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Ecological Land Classification of Kootenay National Park, British Columbia

Vol. I: Integrated Resource Description

Editors: P.L. Achuff, W.D. Holland, G.M. Coen, and K. Van Tighem

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Cover

Map	Annotated air photo of Kootenay Crossing and vicinity.
Upper photo	Mountain goat and kid on limestone near Mt. Wardle. Photo by D.M. Poll.
Centre left	Pileated woodpecker. Photo by G.C. Trottier.
Centre right	Helmet Falls. Photo by P.L. Achuff.
Lower left	Eluviated Dystric Brunisol, CA2 Ecosite, below Vermilion Peak. Photo by W.S. Taylor.
Lower right	Indian paint brush (*Castilleja miniata*) in Vermilion burn near Stanley Glacier trail. Photo by B.D. Walker.

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P.L. Achuff
S.M. Dupuis
W.S. Taylor
B.D. Walker
Alberta Institute of Pedology
University of Alberta
Edmonton, Alberta
T6G 2E1

G.M. Coen
Alberta Pedology Unit
Agriculture Canada
4445 Calgary Trail
Edmonton, Alberta
T6H 5R7

L.W. Gyug
G.L. Holroyd
D.M. Poll
M.M. Porter
R.M. Wershler
K. Van Tighem
Canadian Wildlife Service
Environment Canada
1000, 9942 - 108 Street
Edmonton, Alberta
T5K 2J5

D.T. Allan
H.A. Dudynsky
M.D. Fairbarns
W.D. Holland
Northern Forest Research Centre
Canadian Forestry Service
Environment Canada
5320 - 122 Street
Edmonton, Alberta
T6H 3S5

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PLATES

1. Ice Contact Stratified Drift B in Stoddart Creek valley with extreme textural variability vertically. Stick is 1 m long.

2. Mass movement of glaciolacustrine material on a steep slope along Ochre Creek.

3. Sampled Eluviated Eutric Brunisol of the AL4 Ecosite.

4. Sampled Orthic Eutric Brunisol of the AT1 Ecosite.

5. AT1 sample site with a young, even-aged lodgepole pine/buffaloberry/pine grass (C38) forest.

6. The landslide mapped as BP2 extends along the valley floor from Goodsir Pass (left) westward into YNP (right and background). Unvegetated talus plus rock glacier (middle, left to center) and blocky strips (middleground) mark the landslide boundary. Rockland (R) extends above the T + RG tract.

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18. DG3 landscape with Douglas fir/juniper/bearberry (O5) vegetation.

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20. Sampled Orthic Gray Luvisol of the DR2 Ecosite.

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31. Sampled Rego Gleysol (peaty phase) of the HC1 Ecosite.

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33. Sampled Cumulic Regosol of the HD3 Ecosite.

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38. Sampled Eluviated Dystric Brunisol of the IB4 Ecosite.

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43. LV2 landscape with dominant heather-everlasting (L5, foreground) and subdominant subalpine larch-subalpine fir/heather (O13, middle ground) v.t.s.

44. Sampled Cumulic Regosol of the PP3 Ecosite.

45. Sampled Orthic Sombric Brunisol of the RD2 Ecosite.

46. RD2 sample site with heather-everlasting (L5) vegetation.

47. Sampled Orthic Eutric Brunisol (lithic and turbic phases) of the SB6 Ecosite.

48. Engelmann spruce-subalpine fir/false azalea (C14) forest, here on an SB6 tract, is extensive in the Lower Subalpine.

49. Lodgepole pine/buffaloberry/showy aster (C6) v.t. on SB3.

50. SB1 landscape with a mosaic of avalanche v.t.s. Aspen-dwarf birch/bearberry (S16) is in the foreground and dark green patches of subalpine fir-willow (S2) are near the valley floor.

51. Sampled Gleyed Ferro-Humic Podzol of the SX2 Ecosite.

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53. SX2 sample site with Engelmann spruce-subalpine fir/valerian-fleabane (O9) open forest.

54. Sampled Rego Gleysol (peaty phase) of the VL2 Ecosite.

55. VL2 sample site with the dwarf birch-shrubby cinquefoil-willow/brown moss (S1) v.t.

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57. Sampled Orthic Eutric Brunisol (lithic phase) of the WF3 Ecosite.

58. Engelmann spruce-subalpine fir/grouseberry (C15) forest is dominant on WF5 and subdominant on WF1.

59. A grassy variant of the Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4) v.t. occurs on WF3 tracts in the Western Ranges, particularly in upper John McKay Creek.

60. Sampled Orthic Eutric Brunisol (lithic phase) of the WH4 Ecosite.

61. Landscape near Goodsir Pass with the subalpine larch forest of WH1 (middleground) below the herb and tundra vegetation of WH8 (background).

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63. Steep, craggy slopes dominated by Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4) open forest are typical of WH4.

64. Sampled Orthic Eutric Brunisol of the WY1 Ecosite.

65. Sampled Orthic Humic Regosol occurring under grassland on southerly aspects of WY2.

66. WY1 sample site with Douglas fir/hairy wild rye (C1) forest.

67. Glacial benchland near Stoddart Creek with forest-open forest-grassland mosaic of WY2.

68. Bluebunch wheatgrass-hairy wild rye-showy aster (H19) grassland is common on WY2 and DG3 in scuthwestern KNP.

69. Modifier A (Avalanched) is added to an Ecosite symbol where 20 to 50% of the tract is modified by snow avalanching.

70. Effects of the 1968 fire on vegetation in the Vermilion Pass area. Modifier B (Burned) is added to an Ecosite symbol where ≥50% of the tract has been modified by recent fire.

71. Colluvial Rubble (CR) landscape with solifluction features. Subdued terrain is usually underlain by highly jointed, recessive bedrock. Here the bedrock is Chancellor Formation slate.

72. A steeply sloping Recent Moraine (M) below a small glacier (GL) near Tumbling Pass.

73. A Rock Glacier (RG) in East Verdant Creek valley.

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ABSTRACT

Kootenay National Park is in the Rocky Mountains of southeastern British Columbia between 50° 34' and 51° 19' N and 115° 48 ' and 116° 22' W. The Ecological Land Classification of the park is an integrated resource inventory of landform, soil, vegetation and wildlife information presented in both report and 1:50,000 map format. A three-level, hierarchical land classification system was developed using existing landform and soil classifications plus a classification of 56 vegetation types developed by the authors. The three levels are based on national guidelines for ecological land classification and are, from highest to lowest level of generalization, Ecoregion, Ecosection and Ecosite.

Ecoregion separations are based primarily on vegetation physiognomy and species composition which reflect macroclimate. Montane, Subalpine and Alpine Ecoregions are recognized. The Subalpine Ecoregion is divided into Lower Subalpine and Upper Subalpine based on vegetational characteristics reflecting macroclimatic differences.

The Ecoregions are divided into 31 Ecosections based on broad landform, drainage class and soil differences. Landforms are composed of six genetic materials which are divided into 18 genetic material units based on textural and chemical (calcareousness/reaction) differences.

The Ecosections are divided into 78 Ecosites based on landform, soil and vegetational differences insufficient to warrant separation at the Ecosite level. Ecosites plus nine Miscellaneous Landscapes are the map units delineated. The landforms, soils, vegetation and wildlife of each Ecosite and Ecosite are described. Wildlife information includes the importance of each Ecosite for most of the common animals and descriptions of 14 breeding bird communities and eight small mammal associations.

A total of 256 animal species are recorded in the park, including four amphibians, three reptiles, 191 birds and 58 mammals. A total of 993 plant taxa occurs in the park; 677 are vascular plants, 27 are liverworts, 133 are mosses and 156 are lichens.

CHAPTER I - PHYSICAL ENVIRONMENT

LOCATION, PHYSIOGRAPHY AND DRAINAGE SYSTEMS

B.D. Walker, D.T. Allan and W.S. Taylor

LOCATION

Kootenay National Park (KNP) occupies 1406 km² in the Rocky Mountains of southeastern British Columbia between 50° 34' and 51° 19'N, and 115° 48' and 116° 22'W (Fig. 1) and forms a rough dog-leg shape. It is the southwestern-most of the four contiguous Rocky Mountain National Parks: KNP, Yoho National Park (YNP), Banff National Park (BNP) and Jasper National Park (JNP). KNP shares boundaries with YNP to the north, BNP to northeast, and Mount Assiniboine Provincial Park to the east. The Continental Divide forms the northeast boundary between KNP and BNP. The southwestern map boundary used in this report extends between Stoddart Creek and Mount Berland, and reflects a proposed park boundary change.

KNP is approximately 85 km from north to south and averages 15 km in width, varying from 10 to 25 km. The shape and size are derived historically from the Banff-Windermere Highway (B.C. Highway 93) which extends 94 km through the centre of KNP from the Continental Divide at Vermilion Pass to Radium in the southwest (Patton and Robinson 1978).

PHYSIOGRAPHY

Most of KNP occurs, hierarchically, in the Continental Ranges, Rocky Mountains, Rocky Mountain Area, Eastern System, Canadian Cordillera (Holland 1964, Bostock 1970). A small portion along the southwestern boundary from Stoddart Creek to north of Radium is in the Southern Rocky Mountain Trench, Interior System, Canadian Cordillera (Holland 1964, Bostock 1970).

Physiography and landform development in the Canadian Cordilleran Region are governed by three factors: geomorphic process, bedrock character, and orogenic or structural history (Holland 1964). KNP is predominantly underlain by folded and faulted sedimentary rocks uplifted by orogenic deformation during the Tertiary (Holland 1964). Erosional processes, mainly fluvial and glacial, then have operated to the present. Degree of erosion, hence the general topography, is controlled by differences in hardness of the bedrock. Valleys tend to reflect softer rocks while peaks and ridges are underlain by more resistant beds. In the Rockies, tilted beds may extend for miles and the general topography exhibits a strong linear character with trellis pattern streams (Holland 1964).

KNP displays, in the northwest-southeast trending range and valley systems, physiographic differences related to bedrock character and structural style (Ryder 1981). The Continental Ranges in KNP are divided into Main (or Park) Ranges with eastern and western sectors and Western (or Kootenay) Ranges (Holland 1964, Price and Mountjoy 1970, Cook 1975). With the addition of the Rocky Mountain Trench, KNP touches four physiographic units that reflect geologic subdivisions. The boundaries have been approximated (Fig. 2) from G.S.C. (n.d.), Lewis (n.d.), Holland (1964), Price and Mountjoy (1970, 1972), Reesor (1973), Cook (1975), Price *et al.* (1978, 1980), and Ryder (1981). The boundary between eastern and western Main Ranges is based primarily on physiographic change, whereas the boundary between western Main Ranges and Western Ranges is based on structural change (Cook 1975). The western Main Ranges are physiographically more similar to the Western Ranges than to the eastern Main Ranges (Cook 1975).

Fig. 1. Location and drainage systems of Kootenay National Park.

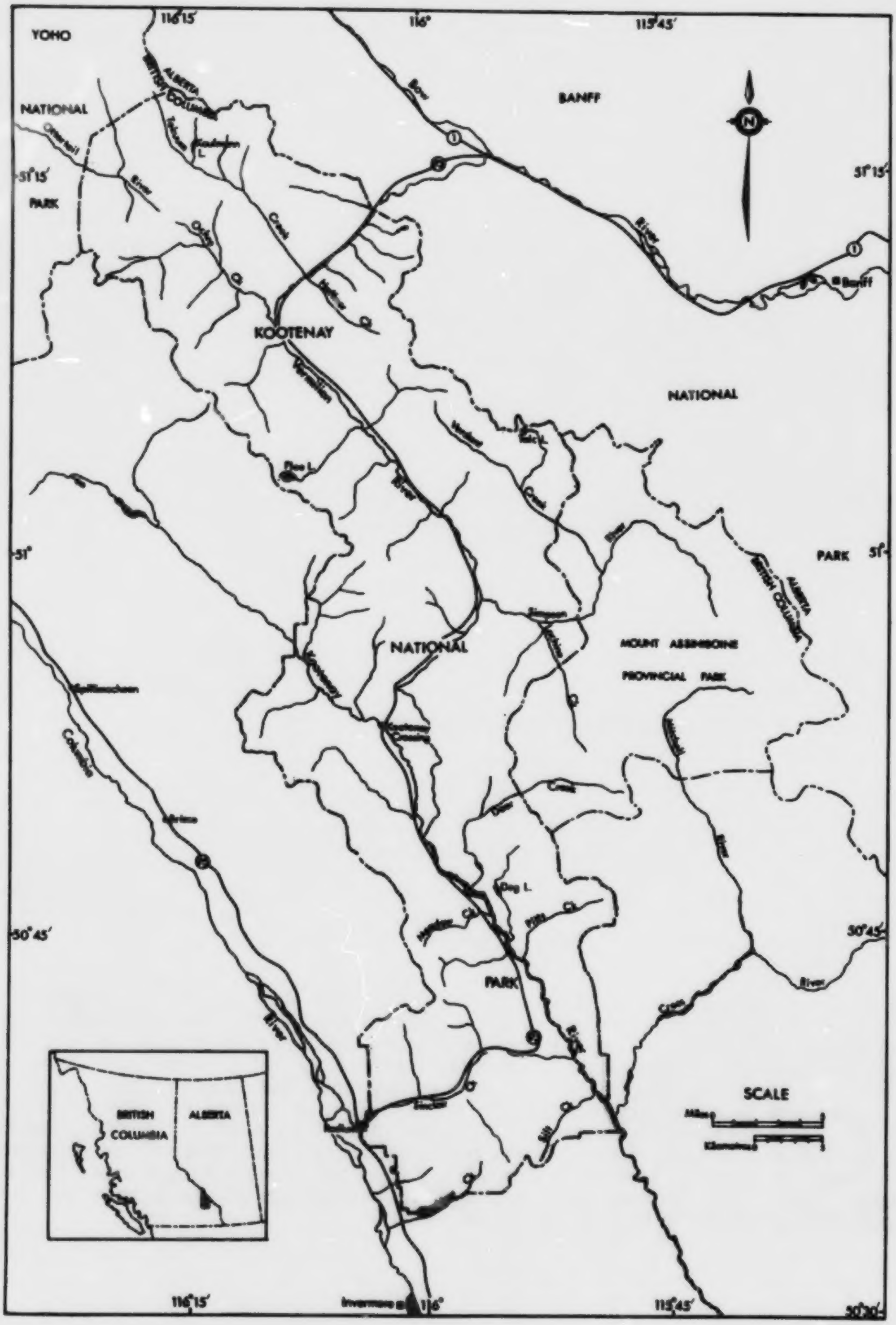
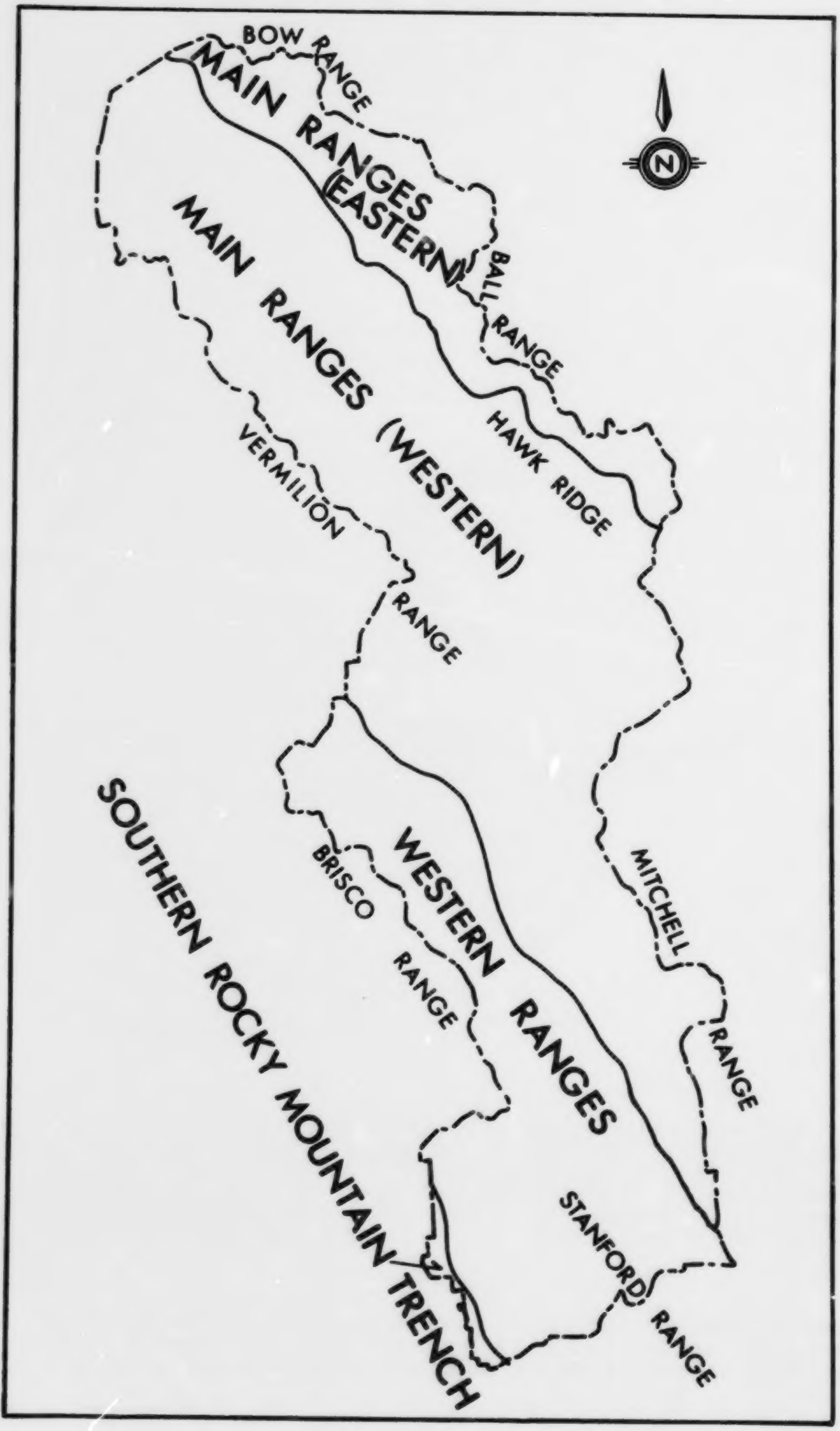

YOHO
NATIONAL
PARK
116°15'
116°
115°45'
51°15'
51°
50°45'
50°20'
ALBERTA
BRITISH COLUMBIA
Bow
River
BANFF
NATIONAL
PARK
Banff
Ottertail
River
L.
Creek
Cr.
KOOTENAY
Vermilion
River
Floe L.
NATIONAL
Simpson
River
Cr.
MOUNT ASSINIBOINE
PROVINCIAL PARK
Kootenay
Crossing
Spillimacheen
Columbia
River
Creek
Dog L.
Pitts Cr.
Cr.
PARK
Cross
River
Sinclair
Cr.
SCALE
Miles
Kilometres
BRITISH
COLUMBIA
ALBERTA
Invermere

Fig. 2. Physiographic subdivisions of Kootenay National Park.


BOW RANGE
MAIN RANGES (EASTERN)
BALL RANGE
MAIN RANGES (WESTERN)
HAWK RIDGE
VERMILION RANGE
N
MITCHELL RANGE
BRISCO RANGE
WESTERN RANGES
SOUTHERN ROCKY MOUNTAIN TRENCH
STANFORD RANGE

The eastern sector of the Main Ranges includes the Bow and Ball ranges area along the Continental Divide in northeastern KNP. There, generally flat to gently dipping, distinctly bedded, dominantly resistant and cliff-forming Precambrian and Cambrian limestones and quartzites have been carved into broad massifs with castellated peaks (Holland 1964, Price and Mountjoy 1970, Cook 1975, Ryder 1981). The highest elevations in KNP are in this area, including Deltaform Mountain (3424 m), Mount Allen (3301 m), Mount Tuzo (3249 m), Mount Fay (3238 m) and Neptuak Mountain (3236 m) of the Wenkchemna Peaks and Mount Ball (3312 m). Valley floors have gentle gradients and are higher than in other physiographic units. Internal relief is 1000 to 1500 m with the upper half generally unvegetated cliffs, crags and rubble-mantled rock. Extensive vegetation occurs on the more gentle, lower mountain slopes, valley floors, cirques, cols and valley shoulders. Other features typical of eastern Main Ranges include well defined cirques and hanging valleys. Glaciers and icefields are also common regardless of aspect. The largest glacier in KNP is unnamed and occurs on the south side of the Wenkchemna Peaks.

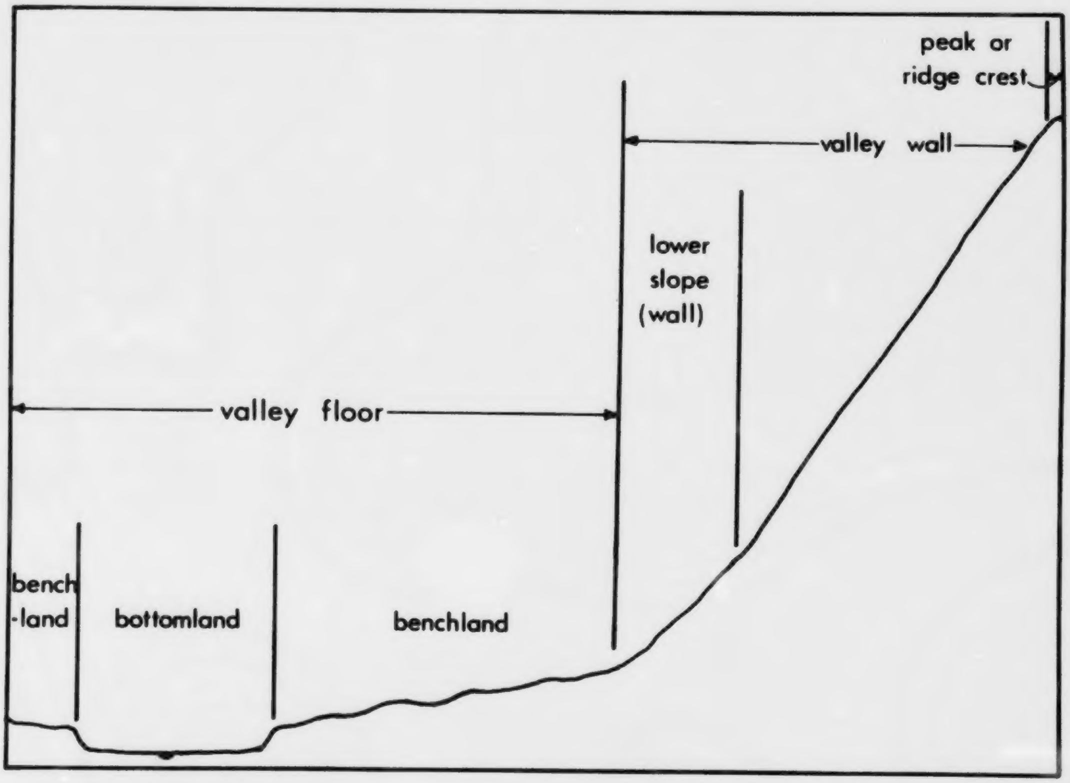
The western sector of the Main Ranges (Fig. 2) stretches from Tokumm, Haffner and Verdant creeks to the Kootenay River (Holland 1964). With the exception of the Vermilion and Mitchell ranges, most of western Main Ranges topography has been carved into relatively homogeneous, indistinctly bedded, cleaved, recessive, shaly and metamorphic rocks giving less craggy mountain slopes than in the eastern sector (Price and Mountjoy 1970, Cook 1975). Mountain and ridge tops tend to be rounded, rubble-strewn and at elevations of 2400 to 2900 m, decreasing to the south and west. The mountain slopes, most of which are vegetated, drop off abruptly 1000 to 1500 m to deeply incised valley floors which have gentle to moderate gradients. The Vermilion and Mitchell ranges form a prominent topographic exception to the generally subdued physiography of the western Main Ranges. They resemble the eastern sector and are characterized by precipitous limestone cliffs culminating in narrow serrated ridges and castellate peaks. The Rockwall in the Vermilion Range epitomizes this exception within the western Main Ranges (Price and Mountjoy 1970). The highest peaks include Foster Peak (3204 m), Helmet Mountain (3139 m), Mount Vérendrye (3086 m), and Mount Sharp (3050 m) in the Vermilion Range and Mount Harkin (2983 m) in the Mitchell Range. These two ranges also contain the best expressed cirques and hanging valleys within the western Main Ranges and shade most of the glaciers (*e.g.* Tumbling Glacier) on their northerly and easterly flanks.

The Western Ranges subdivision is physiographically similar to the western Main Ranges and in southwestern KNP includes landscape associated with the Brisco and Stanford ranges (Fig. 2). It is characterized by complex geologic structures (Ryder 1981) unique in the Canadian Rockies (Holland 1964). The main ridges, *e.g.* the Brisco Range, trend northwest-southeast and are deeply incised and partly dissected by transverse valleys, many of which are along transverse faults (Holland 1964, Price and Mountjoy 1970). Additionally, exposures of randomly alternating resistant and recessive rocks have resulted in alternating stretches of craggy, serrated ridge tops separated by smooth rounded crests. Ridge summits are 2200 to 2500 m and the highest peaks are Mount Kindersley (2692 m) and Mount Sinclair (2662 m). The more prominent valleys (*e.g.* Sinclair and Kimpton creeks) have gentle to moderate gradients. Tributary valleys, such as Meadow and Silt creeks, descend steeply from upper mountain slopes and are often canyon-like over part of their length. Internal relief is generally 1000 to 1500 m giving long, steep, well vegetated mountain slopes. Evidence of glaciation in the Western Ranges is minimal. U-shaped valleys, hanging valleys, and cirques are absent (Holland 1964) or, at best, are poorly expressed (Lewis n.d.). Other evidence for glaciation includes erratics (Holland 1964) and a few small moraines. No glaciers presently exist in the Western Ranges (Falconer *et al.* 1966, Reesor 1973).

Southwestern KNP touches on the Southern Rocky Mountain Trench (Fig. 2). It is the broadest valley in the mountainous area containing KNP. Holland (1964) described the Trench as a structurally controlled erosional feature, but its origin is controversial and not well known (Crickmay 1964). The eastern wall of the Trench is the western front of the Rocky Mountains. Thus, its boundary with the Western Ranges (Fig. 2) coincides with a change from steep middle and upper slopes to less steep, lower valley wall slopes at about 1000 to 1200 m elevation. A benchland above the Columbia River is included in KNP.

The Kootenay and Vermilion river valleys, though narrower than the Columbia River valley, have similar physiographic profiles (Fig. 3). A few other valleys have similar but narrower profiles. Many of the valleys, however, are nearly V-shaped with narrow floors and no benchlands.

Fig. 3. Profile of a broad valley.



DRAINAGE SYSTEMS

KNP occurs within the Columbia Initial Drainage Division (Shera and Grant 1980), also called the Columbia Basin. The basin is divided into major watersheds (Shera and Grant 1980). Most of KNP drains via the Upper Kootenay River Major Watershed. An area in the northwest bordering YNP is part of the Kicking Horse River Major Watershed. The southwestern corner drains via the Columbia River Major Watershed (Shera and Grant 1980). Larger streams and lakes are shown in Fig. 1.

The Ottertail River, flowing northwestward to the Kicking Horse River in YNP, drains a small area in northwestern KNP. The divide between it and the Vermilion River to the southeast includes Misko, Ottertail and Goodsir passes and intervening ridges.

The Vermilion River drains the remainder of northern and eastern KNP. The middle reaches, about half its length, flow southeast parallel to the surrounding northwest-southeast trending mountain structures. However, the upper reaches of the Vermilion River (Vermilion Pass to Ochre Creek) and lower reaches (Simpson River to Hector Gorge) cut across the prevailing mountain structures. One of the most spectacular waterfalls in the mountain parks - the 360 m Helmet Falls - is on the Rockwall in the Vermilion drainage (Patton and Robinson 1978).

The Vermilion is tributary to the Kootenay River which also drains the western slopes of the Vermilion/Mitchell ranges and the eastern slopes of the Brisco/Stanford ranges. The Kootenay flows southeast paralleling the mountains and exits KNP in the southeast corner just above the Cross River confluence. The western slopes of the Brisco and Stanford ranges drain via Sinclair and Stoddart creeks and other small tributaries into the northwestward flowing Columbia River.

Glacial influence on present stream volume and sediment load is strongest in the Vermilion River drainage system. This influence carries over to the Kootenay River below the Vermilion River confluence. Glacial influence, however, is considerably less than on the North Saskatchewan and Athabasca river systems in BNP and JNP where glaciofluvial landforms are presently being formed (Walker *et al.* 1982a). All other streams in the Ottertail, Columbia, and Kootenay river drainages of KNP are unaffected by glaciers.

There are conspicuously fewer and smaller lakes in KNP than in BNP and JNP. The Vermilion drainage contains several lakes including Floe, Kaufmann and Talc lakes. All occur at high elevation (Subalpine and Alpine Ecoregions) in cirques and hanging valleys and are glacier fed, which is typical of Main Ranges physiography. In the Kootenay drainage, most lakes and ponds occur on Montane benchlands of the Kootenay River valley, with the exception of a few, small lakes at high elevation. Usually, lakes are small, bordered by fen, and in poorly drained depressions of glacial landforms. These include Dog, Olive and Cobb lakes. Many lakes are impounded by stream fans. Lakes and ponds are effectively absent from the Ottertail and Columbia drainages.

Limnological studies on lakes (Donald and Alger 1984) and streams (Alger and Donald 1984) in KNP were undertaken to compliment the ecological inventory. In addition, aquatic biophysical information is available for the Upper Kootenay Watershed (R.A.B. 1978, Chamberlin 1980).

CLIMATE

B.D. Walker and P.L. Achuff

OVERVIEW

Climatic data for Kootenay National Park are scarce. Janz and Storr (1977) provide the most comprehensive information in their overview of the four contiguous Rocky Mountain National Parks, while Marshall (n.d.) discusses the climate of the East Kootenay Region, including KNP. Information from Banff National Park (BNP) is used below as a basis for extrapolation where KNP data are inadequate.

KNP has a continental macroclimate which is characterized by brief, cool summers and long snowy winters. The area is generally drier than mountain ranges farther west, *e.g.* the Columbia Mountains, which intercept moisture carried by westerly winds (Janz and Storr 1977).

The mountain topography modifies the macroclimate creating mesoclimatic and microclimatic gradients. The predominant northwest-southeast orientation of mountain ranges and valleys is nearly perpendicular to the prevailing winds aloft and influences precipitation distribution, winds, and the intrusion of Arctic air from the prairies to the east (Marshall n.d., Powell 1970, Janz and Storr 1977).

EAST - WEST CLIMATIC TRENDS

Temperature and precipitation data indicate that areas west of the Continental Divide experience a stronger maritime influence than areas to the east. Areas west of the Divide at similar elevation are moister than areas to the east (Table 1), except perhaps in extreme southwestern KNP. This precipitation pattern is due to upslope lift of moist westerly air and is best illustrated during winter chinooks. During chinooks (Janz and Storr 1977), most park areas experience milder weather but temperatures and winds are higher east of the Divide. Conversely, precipitation is higher in the western side and increases with increasing elevation. The temperature of the air descending the eastern slopes rises in accordance with the dry adiabatic lapse rate (*i.e.* 9-10°C/km). Hence, little or no precipitation occurs east of the Divide during chinooks.

Temperature range (difference between extreme maximum and minimum, Table 2) illustrates the reduced continentality west of the Divide, but it is unclear that the climate here is milder than that east of the Divide. Janz and Storr (1977) consider KNP to be milder than BNP based on winter mean minimum temperatures (compare Boulder Creek and Sinclair Pass with Banff townsite, Table 2). Extreme and mean minimum temperatures support this conclusion, except for mean minima for Kootenay Crossing (Table 2), and illustrate the blocking of Arctic air from the east by the Continental Divide during winter. However, mean annual temperatures for Kootenay Crossing, Boulder Creek, and Sinclair Pass *vs.* Banff townsite (Table 2) suggest a cooler climate west of the Divide. Mean maxima for Sinclair Pass *vs.* Banff also support this position. The lower mean annual temperature at Sinclair Pass *vs.* Banff is due to lower mean maxima for all months and lower mean minima for eight months (Atmospheric Environment 1975a). Kootenay Crossing is inexplicably and unusually cool for its elevation and western Rockies location. Thus, while KNP is milder than BNP when judged on temperature extremes, it is cooler when mean temperatures are compared.

The moister, perhaps milder climate of KNP is reflected by vegetation and soils. The Engelmann spruce-subalpine fir/false azalea (C14) and lodgepole pine/false azalea/grouseberry (C20) vegetation types (v.t.s) are widespread in the Lower Subalpine of KNP whereas, east of the Divide, the distribution is more restricted, primarily to northerly and easterly aspects of western BNP (Corns and Achuff 1982). Two soil differences appear to reflect climatic conditions, although this may be due in part to differing lithologies. Luvisolic soils are more restricted in distribution and Podzolic soils less restricted in KNP than in BNP (Walker *et al.* 1982c).

Marshall (n.d.), McLean and Holland (1958), and Powell (1970) single out the area around Invermere in the Southern Rocky Mountain Trench as semiarid. The southwestern part of KNP is adjacent to this area (Janz and Storr 1977) and contains comparatively dry soil and vegetation including natural, semiarid grassland. Precipitation in the Trench, especially winter precipitation (Powell 1970, Tables 1 and 2), decreases and temperature increases up-valley. Powell (1970) mentions that the rain-shadow of the Columbia Mountains is most marked in the Invermere area. This trend may spill over to the Kootenay River valley immediately south of KNP (note the Palliser River station mean annual precipitation, Table 1).

CLIMATE AND ECOREGIONS

Vegetation, as a biotic component of an ecosystem, reflects climate. Thus, vegetational features have been used to delimit climatic units. Based primarily on vegetation physiognomy and composition, four units have been delineated: Montane Ecoregion, Subalpine Ecoregion with Lower Subalpine and Upper Subalpine portions, and Alpine Ecoregion.

Table 1. Mean annual precipitation (MAP) in mm for stations in and near KNP.

Station	Elevation	MAP	% as snow
Montane		$\bar{x}=457$ mm	
Spillimacheen	820 m	409[1] 452[2]	30 36
Brisco	825 m	420[1] 427[2]	31 33
KNP West Gate	900 m	366[2]	34
KNP Admin.	1000 m	455[3]	nd
Stoddart Creek	1005 m	270[4]	nd
Palliser River	1035 m	386[5]	nd
KNP Radium	1090 m	511[1] 547[2]	32 35
KNP Kootenay Xg.	1170 m	505[2]	42
YNP Boulder Creek	1220 m	557[2]	45
Sinclair Pass	1370 m	608[1]	43
Banff	1395 m	477[1] 471[2]	43 44
Lower Subalpine		$\bar{x}=747$ mm	
Albert River	1280 m 1310 m	800[5] 818[5]	nd nd
KNP Marble Canyon	1485 m	809[3]	nd
Lake Louise	1525 m	768[1] 684[2]	63 62
Brewster Creek	1575 m 1600 m	571[5] 781[5]	nd nd
Upper Subalpine		$\bar{x}=932$ mm	
Fatigue	2135 m	870[5]	nd
Sunshine Village	2190 m	996[5]	nd

[1] Atmospheric Environment (1975b): 1941-70, 5-30 yrs. data.
[2] Atmospheric Environment (n.d.a & n.d.b): 1951-80, 5-30 yrs. data.
[3] Meteorological Branch (n.d.): 1-3 yrs. data.
[4] Waste Management Branch, Brit. Col. Min. Env. (pers. comm. 1983): 1 yr. data.
[5] Atmospheric Environment (n.d.c): 5-12 yrs. data.

Table 2. Temperature data (°C) for stations in and near KNP.

Station and Source	Ecoregion	Ext. Max.	Ext. Min.	Yrs. of Record	Mean Maxima May	June	July	Aug.	Sep.	Mean Minima Nov.	Dec.	Jan.	Feb.	Mar.	Mean Annual
Spillimacheen[1,2] 50°55'N, 116°24'W, 818 m	Montane	36.7	-40.0	17-22	18.6 18.4	21.4 21.5	25.6 25.1	23.9 23.6	18.8 17.7	- 5.9 - 6.0	-11.2 -11.1	-14.7 -14.2	-11.2 - 9.8	- 6.9 - 5.9	4.3 4.4
KNP West Gate[1,2] 50°37'N, 116°4'W, 899 m	Montane	36.1	-37.8	11-12	18.2 18.4	21.1 21.6	25.8 25.9	24.1 24.7	18.6 18.5	- 5.2 - 5.4	- 9.9 -10.0	-12.4 -12.0	- 9.4 - 8.0	- 6.3 - 4.6	4.9 5.3
KNP Radium[1,2] 50°39'N, 116°1'W, 1088 m	Montane	36.7	-32.8	13-16	17.5 17.2	20.9 20.4	25.7 24.9	24.2 24.0	18.6 17.8	- 6.6 - 7.2	-11.3 -11.5	-14.1 -14.1	-10.6 - 9.8	- 6.9 - 6.9	4.0 3.8
KNP Kootenay Xg.[2] 50°52'N, 116°3'W, 1170 m	Montane	35.0	-42.8	10-14	16.2	20.0	24.1	23.0	16.8	-10.6	-15.8	-18.1	-14.4	-10.5	1.7
YNP Boulder Creek[2] 51°23'N, 116°32'W, 1219 m	Montane	33.0	-35.0	7-10	15.7	19.7	23.7	22.2	16.7	- 8.4	-12.0	-14.5	-10.3	- 7.5	2.9
Sinclair Pass[1] 50°40'N, 115°58'W, 1370 m	Montane	36.1	-42.2	10-19	13.8	16.8	21.6	20.5	14.6	- 9.8	-12.9	-15.1	-11.7	- 9.3	1.6
Lake Louise (Village)[1,2] 51°25'N, 116°10'W, 1524 m	Subalpine (Lower)	34.4	-52.8	57-64	13.6 13.2	17.3 17.1	21.4 21.0	20.1 19.9	15.1 14.6	-13.3 -13.9	-18.6 -19.0	-21.4 -22.0	-17.7 -17.9	-14.4 -14.8	-0.1 -0.4
Banff (townsite)[1,2] 51°11'N, 115°34'W, 1397 m	Montane	34.4	-51.1	87-92	14.2 14.2	17.8 18.1	22.3 22.3	21.0 21.1	16.0 15.9	- 8.3 - 8.2	-13.1 -13.0	-16.3 -16.4	-12.9 -12.0	-10.1 - 9.4	2.3 2.5

Source: [1] Atmospheric Environment (1975a) - adjusted or actual normals (1941-70), 5-30 years data.
[2] Atmospheric Environment (n.d.a & n.d.b) - adjusted or actual normals (1951-80), 5-30 years data.

MONTANE ECOREGION

Most of the climatic data for KNP are from the Montane Ecoregion (Tables 1 and 2) which is the warmest and driest, especially in extreme southwestern KNP. Mean annual temperature is >1°C and the Montane experiences the greatest temperature range with extreme minima of -35° to -45°C (Janz and Storr 1977). Maxima above 32°C are relatively rare (Janz and Storr 1977). Summer frost is infrequent which indicates mild climate.

Inversions are common (Marshall n.d., Powell 1970, Janz and Storr 1977) with a shallow diurnal variety occuring most nights, especially in summer. KNP occasionally experiences subsidence inversions of several days to weeks duration in fall (Janz and Storr 1977). Cold Arctic air may produce deep, prolonged, fall and winter inversions (Janz and Storr 1977). The result, particularly of the diurnal inversion, is cold air drainage to the valley bottoms and a *thermal belt* with warmer temperatures on valley walls. In southwestern KNP, *thermal belts* affect the upper part of the Montane and, in northeastern KNP, the Lower Subalpine. Powell (1970) has linked *thermal belts* to the distribution of insects and diseases, *e.g.* mountain pine beetle on southwesterly slopes.

Mean annual precipitation in the Montane is 300 to >600 mm (Table 1). Precipitation regime is typical for Montane areas (Holland *et al.* 1982) with maximum precipitation in summer (usually June), a second peak in winter, and minimum in late winter or early spring, especially in March or April. Mean annual snowfall is 30 to 45% of the total precipitation. Southern KNP has the lowest frequency of precipitation in the four contiguous parks, yet snowfall is more reliable and less variable than east of the Continental Divide (Janz and Storr 1977). Heavy precipitation west of the Divide during chinooks (Janz and Storr 1977) and wind and precipitation patterns suggest that the Montane of KNP is much less frequently snow-free in winter than the Montane of BNP and JNP. Snow course data from Sinclair Pass for February, March and April show no zero readings over a 33 to 45 year period (Inventory and Engineering Branch 1980).

Few wind records are available. West of the Continental Divide, winds are generally light in the valleys and periods of calm are frequent (Janz and Storr 1977). Surface wind direction is determined by topography. Powell (1970) indicates that main wind directions in the Trench are northwest or southeast, parallel with its alignment. In summer, there is also a strong northeast component and wind speeds are higher with few periods of calm (Powell 1970).

SUBALPINE ECOREGION

The Subalpine Ecoregion occurs at elevations above the Montane Ecoregion and is cooler and moister. There are few climatic data from the Subalpine in KNP (Tables 1 and 2), therefore, Lake Louise in BNP is used as a guide and trends are assumed similar to those of BNP and JNP (Holland *et al.* 1982), recognizing the differences west of the Continental Divide. Mean yearly temperature in the Subalpine Ecoregion of KNP is probably <1°C and decreases with increasing elevation (*i.e.* about 0.5°C/100 m). Janz and Storr (1977) suggest that higher elevation areas rarely have temperatures above freezing in December to February. Temperature fluctuation is narrower in the Subalpine than the Montane.

Precipitation generally increases with increasing elevation (Tables 1 and 3) and areas west of the Divide are moister than to the east. April snow depth averages about 30 cm deeper west of the Divide than at localities at the same elevation to the east. Snow depths for Floe Lake (Table 3) suggest that it is moister than most of KNP. This is supported by the abundance of Podzolic soils in the area and the occurrence of western red cedar forest at low elevations in Vérendrye and Serac creek valleys. The precipitation regime appears to be a well defined winter maximum (November to January) and a weak secondary maximum in summer (Janz and Storr 1977, Atmospheric Environment n.d.b).

Table 3. Snow depths for stations in and near KNP. (Inventory and Engineering Branch 1980)

Station and elevation	Mean Snow Depth (cm)		
	March 1	**April 1**	**May 1**
Sinclair Pass (1370 m)	62	52	19
Marble Canyon (1520 m)	128	126	94
Vermilion R. #3 (1570 m)	111	105	72
Vermilion R. #5 (1570 m)	104	99	76
Vermilion R. #2 (1610 m)	136	111	68
Vermilion R. #1 (1680 m)	138	129	87
Vermilion R. #4 (1680 m)	113	111	80
Floe Lake (2090 m)	211	232	210
Mt. Assiniboine (2230 m)	161	181	175

Winds are generally light but increase with elevation. The windiest localities include passes and the highest Subalpine elevations where krummholz open forests are prevalent.

ALPINE ECOREGION

The Alpine Ecoregion occurs at elevations above the Subalpine Ecoregion and has the coldest, most rigorous climate as demonstrated by the lack of forest vegetation. Cool mean temperatures are inferred from temperatures at lower elevations (Janz and Storr 1977). Temperature range is probably narrowest in the Alpine. Precipitation increases with altitude but somewhere in the Alpine the trend may reverse.

Winds are important in the Alpine. Janz and Storr (1977) report that all areas above about 2300 m are windy but winds may be light for several days in succession, particularly in summer. Erodible, exposed surfaces are often deflated and snow is redistributed by wind. Complex vegetation patterns in the Alpine are often linked to varying topographic exposures and resultant snow depth variability.

GEOLOGY

W.S. Taylor

REGIONAL SETTING

KNP lies within the southern portion of the Rocky Mountain Thrust Belt, the most southeasterly sector of the Canadian Cordilleran Orogen. The Cordilleran Orogen is part of a circum-Pacific orogenic belt that is generally 800 km wide and is the present expression of the Cordilleran Geosyncline, which has been evolving since mid-Proterozoic time. At present the region is tectonically quiet (Douglas *et al.* 1970).

STRATIGRAPHIC FRAMEWORK

Depositional basin history of the Cordilleran Geosyncline was outlined by Douglas *et al.* (1970) and Price and Mountjoy (1970). Strata representing the period from late Proterozoic to Middle Devonian are exposed in KNP. They reflect deposition in a slowly subsiding, miogeosyncline shelf sequence.

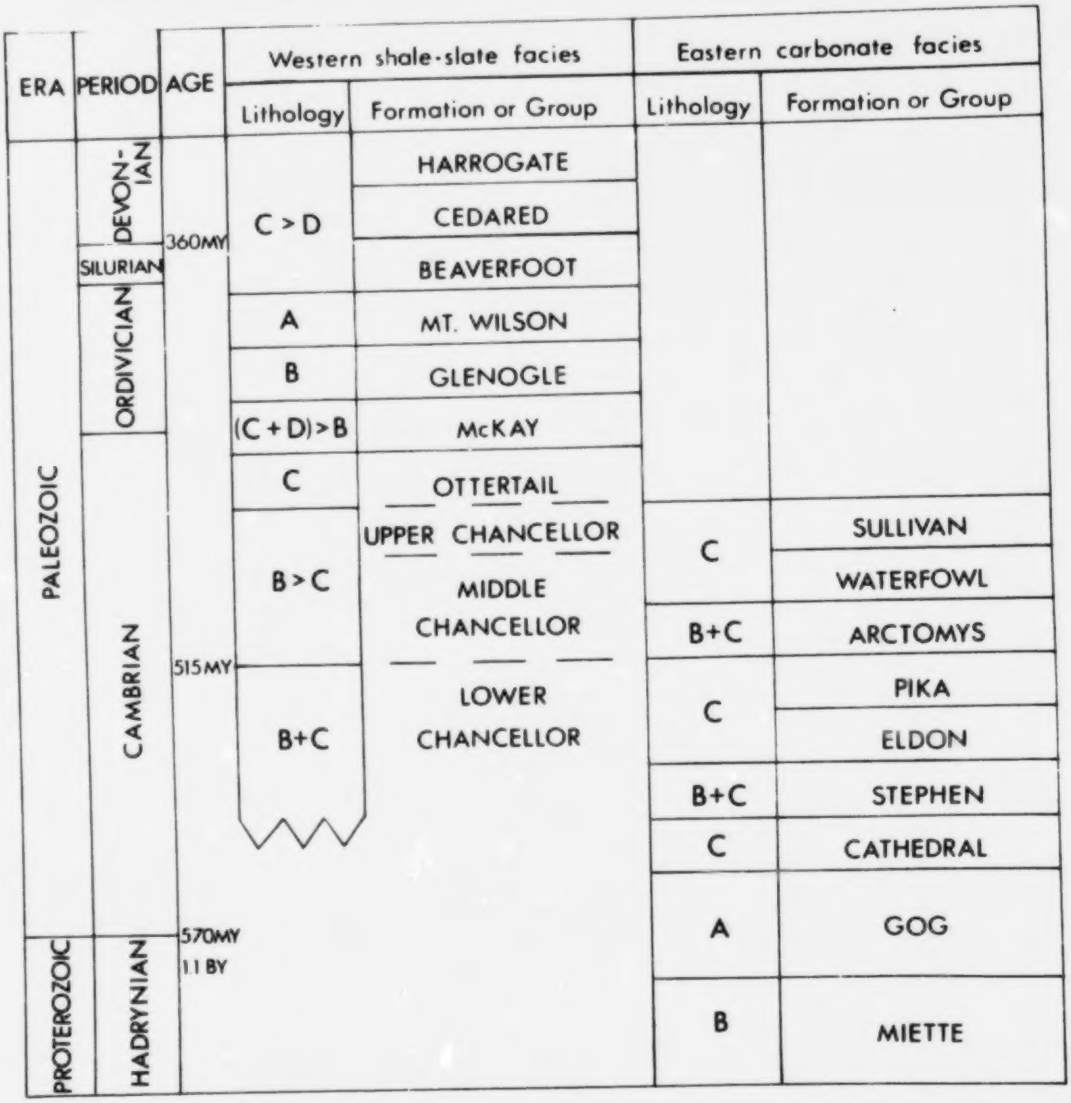
Strata of the geosyncline have been classified into named rock-stratigraphic (lithology dependent) units. From the Lower Cambrian and earlier, the strata are detrital rock, generally noncalcareous because materials were derived from the North American craton to the northeast. An eastern carbonate and western shale facies are evident in the exposed middle Cambrian to Devonian succession (Price and Mountjoy 1970). A generalized stratigraphic column for KNP (Fig. 4) has been compiled from Price and Mountjoy (1970), Reesor (1973), Cook (1975) and Price *et al.* (1978).

Since there is often a close relationship between the characteristics of surficial sediments and the source bedrock (Rutter 1972, Stalker 1973), four bedrock categories have been devised in this report (Fig. 4). They reflect a broad generalization of the Group and Formation lithology descriptions from geology reports, and were observed to correlate with the calcareousness and textural properties exhibited by unsorted (residual, colluvial, morainal) genetic materials derived from them (Table 4). Thus, there is an inferred link between the named Groups and Formations (Fig. 4) and Ecosites described in this report, especially those on residual, colluvial, and morainal genetic materials. The fourth bedrock category in Table 4 is an addition for KNP, while the first three are common to both this and the Banff-Jasper reports (Taylor 1982).

The broad structural and tectonic elements of the Rocky Mountain Thrust Belt were outlined by Douglas *et al.* (1970) and discussed in more detail by Price and Mountjoy (1970). The common understanding that the Rockies were uplifted during the Larimide Orogeny, a period of deformation that lasted from late Upper Cretacious to Oligocene (Douglas *et al.* 1970), is questioned by Price and Mountjoy (1970). They suggest that there was no implicit separation between the influence of the Columbian and later Larimide Orogenies on the eastern portion of the Cordilleran Geosyncline. Thus, mountain building probably occurred in successive pulses from late Jurassic to Eocene. Orogenic deformation is generally thought to have been independent of the crystalline basement, although Gussow (1977) showed basement rock may be involved in the KNP vicinity. Dominant structural features are discrete, discontinuous, interleaved and overlapping thrust faults. Thrust sheets were northeasterly foreshortened along the faults and are now stacked on the flank of the North American craton.

Most KNP bedrock shows low grade metamorphism associated with burial. No volcanism is evident, but there may be plutonism where a portion of the Ice River complex crops out in northwestern

Fig. 4. Stratigraphic column for Kootenay National Park.



ERA	PERIOD	AGE	Western shale-slate facies: Lithology	Western shale-slate facies: Formation or Group	Eastern carbonate facies: Lithology	Eastern carbonate facies: Formation or Group
PALEOZOIC	DEVONIAN		C > D	HARROGATE		
				CEDARED		
	SILURIAN	360MY		BEAVERFOOT		
	ORDOVICIAN		A	MT. WILSON		
			B	GLENOGLE		
			(C + D) > B	McKAY		
	CAMBRIAN		C	OTTERTAIL		
			B > C	UPPER CHANCELLOR	C	SULLIVAN
						WATERFOWL
				MIDDLE CHANCELLOR	B+C	ARCTOMYS
		515MY	B+C	LOWER CHANCELLOR	C	PIKA
						ELDON
					B+C	STEPHEN
					C	CATHEDRAL
		570MY			A	GOG
PROTEROZOIC	HADRYNIAN	1.1 BY			B	MIETTE

A Noncalcareous, medium and coarse grained clastic

B Noncalcareous, medium and fine grained clastic

C Carbonate or calcareous medium grained clastic

D Fine grained carbonate and fine grained calcareous clastic

Table 4. Correlation of bedrock with unsorted genetic material.

Generalized bedrock lithology	Calcareousness and texture of unsorted genetic material
Noncalcareous, medium & coarse grained, clastic	Noncalcareous, coarse textured
Noncalcareous, medium & fine grained, clastic	Noncalcareous, medium textured
Carbonate or calcareous, medium grained, clastic	Calcareous, medium textured
Fine grained carbonate & calcareous, fine grained, clastic	Calcareous, fine textured

KNP. It has most frequently been interpreted as a Paleozoic alkaline intrusive complex (Currie 1975) but instead may be Precambrian crystalline basement brought to the surface by faulting (Gussow 1977).

Erosion subsequent to orogeny has exposed four subparallel, northwest-southeast trending, geological subprovinces in the Rocky Mountains at the latitude of KNP. Subprovinces from east to west are: Foothills, Front Ranges, Main Ranges and Western Ranges. Each has distinctive stratigraphic, structural and topographic features. Boundaries can only be approximated, because the trace of features is often offset or discontinuous. The Foothills Subprovince is effectively absent from the four contiguous Rocky Mountain National Parks. The small area of eastern Jasper National Park that is geographically Foothills (Taylor 1982) is entirely valley floor and expresses no typical Foothills features. Other subprovinces are well represented. KNP straddles both Main and Western Ranges (Fig. 2). The Main Ranges Subprovince has been further subdivided into eastern and western sectors (Price and Mountjoy 1970, Cook 1975). The eastern sector of the Main Ranges is developed in the eastern, carbonate-dominated geologic succession (Fig. 4). The distinctively bedded rock is normally flat-lying to gently dipping because folds are broad and open. Competency and resistance to erosion have produced the high, nonlinear, castellated peaks and the topographic culmination that includes the Continental Divide.

The western sector of the Main Ranges is developed in the western, shale-dominated facies. Its structural style is characteristically internal deformation of beds rather than folding. The chief structural element is penetrative cleavage related to the high clay content of the rock, with only local areas of complex, northeasterly overturned folding (Price and Mountjoy 1970, Cook 1975). Metamorphism to slates is pronounced in the western sector. Structure exerts little control on the comparatively subdued topography. The Chancellor Formation (Fig. 4) underlies a majority of the western sector of the Main Ranges. There are lesser exposures of the Ottertail Formation and McKay Group, usually at higher elevations.

The Western Ranges Subprovince is also developed in the western facies (Fig. 4), but in McKay Group and younger strata in KNP. Structurally, the Western Ranges are characterized by southwesterly overturned folds and fault slices (Price and Mountjoy 1970). The carbonates and sandstones were more resistant to deformation and erosion than the slates of the western Main Ranges and form rugged northwest trending ridges locally offset along transverse faults. Topographically, however, the western Main Ranges and Western Ranges are more similar than the western and eastern Main Ranges.

Location of the geological subprovinces and sectors is shown in Fig. 2. By integrating this information with Fig. 4 and Table 4, one can deduce the relationship of an Ecosite on unsorted materials at a given location with strata that were the probable source of the materials. For example, an Ecosite on noncalcareous, coarse textured till in the eastern Main Ranges probably has the Gog Group as the source strata. More precise correlation can be achieved by comparing the ELC maps to geological maps (G.S.C. n.d., Price and Mountjoy 1972, Reesor 1973, Cook 1975, Okulitch and Woodsworth 1977, Price *et al.* 1978, Price *et al.* 1980).

GEOMORPHOLOGY

B.D. Walker, D.T. Allan and W.S. Taylor

OVERVIEW

Soil and vegetation development is influenced by landform. Landform consists of genetic material, surface expression, and modifying processes (C.S.S.C. 1978a). Genetic materials are emphasized in this section and are defined, with slight modification, according to the C.S.S.C. (1978b) landform classification system. Ryder (1981) presented a similar terrain classification system for the East Kootenay area. Genetic materials are organized into four groups: consolidated (bedrock), unconsolidated mineral, organic, and ice.

UNCONSOLIDATED MINERAL COMPONENT

The unconsolidated mineral group is divided by mode of formation or deposition into ten genetic material classes modified from C.S.S.C. (1978a). They are listed in Table 5 in order of increasing source diversity, increasing influence on properties by depositional agents, and decreasing bedrock lithology influence. Six classes are important to Ecosection/Ecosite separations in the KNP Ecological Land Classification legend.

Genetic material classes are subdivided according to textural and chemical (calcareousness) properties imparted either by source area lithology or modified by depositional media. Nineteen genetic material units (Table 5) occur in KNP but only 12 were used for separations in the land classification. These units correspond to the genetic material units identified for the BNP and JNP Ecological Land Classification (Walker *et al.* 1982a).

RESIDUAL GENETIC MATERIAL

Residual material (R^U) is physically and chemically weathered bedrock and includes saprolite (C.S.S.C. 1978a). Residual material was derived from recessive, medium and fine grained, highly jointed, clastic bedrock and shows vestiges of original bedding structure. It may be either noncalcareous or calcareous, medium or fine textured, and is divided into three genetic material units (Table 6).

Surface occurrences of residual material are rare and not mappable at 1:50,000 in KNP. Thus, no separations in the Ecological Land Classification legend are based on it. But residual material, particularly units A and C, often occur beneath shallow colluvial and morainal deposits. The thickness, rarely exceeds 1 m and the upper boundary to the overlying material may be abrupt or gradual. Topographic expression of residual material conforms to the underlying parent rock. The lower boundary is usually gradual and consolidation increases with depth.

Residuum A

Residuum A is non- to weakly calcareous and medium textured (Table 6) with abundant slaty to flaggy coarse fragments. The principal source in KNP was the low lime slates of the Chancellor Formation but there are localized occurrences on other strata, notably the Glenogle Formation and Miette and McKay Groups. Sola developed in Residuum A and associated overlying materials are acidic (pH <6.5). Consequently, the characteristics, though expanded in KNP to include a low lime phase (Walker *et al.* 1982a), are effectively the same as in BNP and JNP.

Table 5. Characteristics of modal unconsolidated mineral genetic materials in KNP.

Genetic material derived from increasingly diverse bedrock lithology

Origin	Genetic Material Symbol[1]	Genetic Material Class[2]	Characteristics		Genetic Material Unit
			Calcareousness	Texture	
Bedrock	R^U	Residual	noncalcareous	medium	Residuum A
			calcareous	medium	Residuum B
			calcareous	fine	Residuum C
	C^A	Landslide	variable	variable	Landslide material
Gravity	C	Colluvial	noncalcareous	coarse	Colluvium A
			noncalcareous	medium	Colluvium B
			calcareous	medium	Colluvium C
			calcareous	fine	Colluvium D
	M	Morainal	noncalcareous	coarse	Till A
			noncalcareous	medium	Till B
Ice			calcareous	medium	Till C
			calcareous	fine	Till D
	M^{FG}	Ice Contact Stratified	calcareous	variable	Ice Contact stratified Drift B
			noncalcareous	variable	Ice Contact stratified Drift C
	F^G	Glaciofluvial	calcareous	coarse	Glaciofluvial material B
Flowing Water	F	Fluvial	calcareous	coarse-stratified	Fluvial material B
	F^L	Fluviolacustrine	altered	fine-stratified	Fluviolacustrine material A
			calcareous	fine-stratified	Fluviolacustrine material B
Still water	L^G	Glaciolacustrine	calcareous	fine	Glaciolacustrine material[3]
Air	E	Eolian	altered	medium	Eolian material B

[1] Abbreviations from C.S.S.C. (1978a) except for R^U, C^A, M^{FG}, and F^L which are defined in this section.

[2] Modified from C.S.S.C. (1978a) as outlined in this section

[3] Mapped and described as part of Ice Contact Stratified Drift B.

Table 6. Characteristics of residual genetic material units.

Genetic Material Unit	Dominant Source	Calcareous-ness	Textural Properties	
			Fine Earth	Coarse Fragments
Residuum A	Non- to weakly calcareous, medium to fine grained, clastic bedrock	<5% $CaCO_3$ equivalent	20-60% sand, 0-20% clay	50-90%
Residuum B	Calcareous, medium to fine grained, clastic bedrock	5-40% $CaCO_3$ equivalent	20-60% sand, 0-20% clay	50-90%
Residuum C	Calcareous, fine grained, clastic bedrock	5-40% $CaCO_3$ equivalent	<20% sand, 10-30% clay	0-70%

Residuum B

Residuum B is calcareous and medium textured with abundant coarse fragments (Table 6) including angular, channery, slaty, shaly and flaggy material. It is distributed sporadically throughout KNP on calcareous, medium to fine grained portions of various strata. In southwestern KNP, Residuum B occurs with the finer textured Residuum C and the distribution of each is unpredictable. Lower sola developed in Residuum B and overlying materials are neutral to alkaline (pH >6.5) and the material is the same as described for BNP and JNP (Walker *et al.* 1982a).

Residuum C

Residuum C occurs in southwestern KNP primarily on slates and shales of the McKay Group. It is labelled calcareous and fine textured, although the fine earth fraction is dominated by silt size particles (Table 6) and touches on the silt, silt loam and silty clay loam textural classes (Fig. 5).

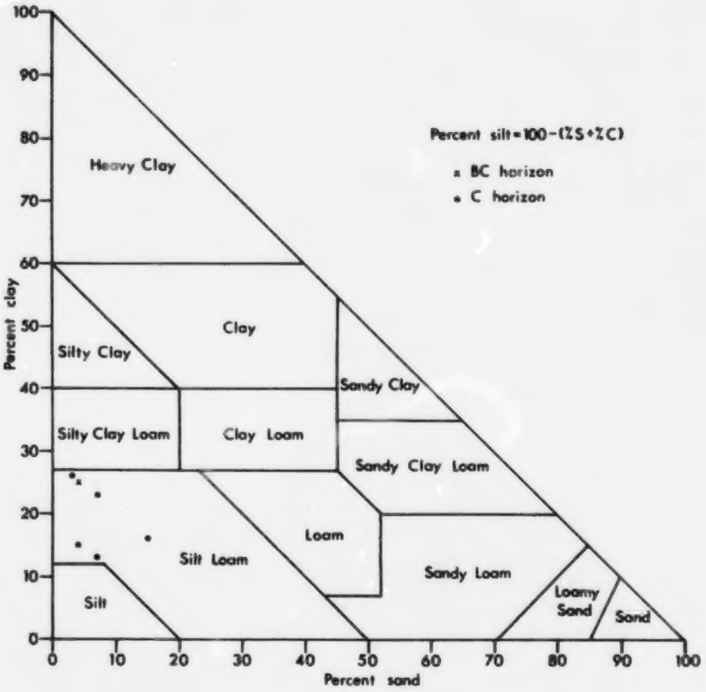
Coarse fragment content of Residuum C is usually <70% and its variability is dependent on hardness stratification in the bedrock. Residuum C normally contains angular to thin, flat clasts. But at many sites on valley benchlands and lower slopes, especially in the Kootenay River valley, the clasts are softer than 3 on Moh's hardness scale and thus, in agreement with Ryder (1981), are not considered coarse fragments. There is a striking similarity between this silty residuum containing soft clasts and a deposit, called clay-till by Kelley and Sprout (1956) and later named Cedrus Till (Lewis n.d., Kelly and Holland 1961, Ryder 1981). Lewis (n.d.) also mentioned the occurrence of residuum derived from McKay strata in several valleys of the East Kootenay Region.

Residuum C is normally calcareous and lower sola developed in it are usually medium acid to alkaline (pH >5.5). Because of geologic complexity in the Brisco and Stanford ranges, all three residual material units plus intergrades occur. This variability is recognized in Ecosite definitions and the intergrades are not labelled.

LANDSLIDE GENETIC MATERIAL

Landslide genetic material (C^{A}) is generated by rapid, gravity-induced movement of mineral material downslope *en masse*. It represents a subset of colluvial material as defined by C.S.S.C. (1978a). Cruden (1976) described several large rock slides in the Rockies and speculated on their causes. There

Fig. 5. Textural variation among selected samples of Residuum C.



are three mapped landslide deposits, all on valley floors in northern KNP. Two consist chiefly of limestone material. The third is mostly slaty material from a slope underlain by middle Chancellor Formation. Differences in characteristics reflect the different lithologies but, due to its limited occurrence and in keeping with BNP and JNP methodology (Walker *et al.* 1982a), landslide material was not further divided.

Coarse fragments are more prominent than fine earths in landslide material and comprise 50 to 100% by volume. Slides from massive limestone have blocky coarse fragments (angular fragments >256 mm), occasionally as large as a house. Medium textured fine earths and rubble (angular fragments 2-256 mm) occur in the weathering zone. The fine earths usually disappear at >1 m and the material becomes fragmental with large voids. The well vegetated, limestone dominated landslide (BP2) at Goodsir Pass has a discontinuous, silty surficial veneer. It was probably eolian but has been reworked by slope wash and solifluction. The veneer is thin and discontinuous so that the ground surface remains exceedingly to excessively stony. Sparsely vegetated landslides (*i.e.* Miscellaneous Landscape CL in Tokumm Creek valley) have little exposed fine earth fraction.

The slaty landslide (IB4) on Ochre Creek is rubbly with a few large blocks and contains more fine earth material than the limestone slides. Textures become coarser with depth and range from silt loam to loamy sand, all with low clay content. The material may become fragmental at about 2 m but surface stoniness is less than on limestone landslides. The textural properties of the slaty landslide reflect the highly jointed, recessive character of the parent rock and its disintegration due to cataclysmic failure.

Limestone landslides are extremely calcareous (>40% $CaCO_3$ equivalent). Where soils are present, the lower sola tend to be neutral to alkaline (pH >6.5). Slaty landslide material is non- to weakly calcareous and sola are acidic (pH <6.5) and more deeply weathered.

Hummocky surfaces of landslide material reflect landform genesis rather than control by underlying bedrock. Slopes are 15 to 70%, highly complex, and of various lengths. Morainal material is thought to underlie the landslide deposits at various depths. If so, the landslides are postglacial. However, parts of the Goodsir Pass landslide resemble an extinct rock glacier of uncertain age.

COLLUVIAL GENETIC MATERIAL

Colluvial genetic material (C) is generated by gravity-induced slow mass movement and/or rapid downslope displacement of isolated mineral fragments. It represents a subset of colluvial material as defined by C.S.S.C. (1978a). Soil creep, rockfall and snow avalanching, with avalanche related fluvial activity including mudflows (Ryder 1981), are the main processes responsible for colluvial material accumulation. This material is generally postglacial and mantles steep valley walls. Four colluvial genetic material units (Colluvium A, B, C, and D) are distinguished by textural and chemical properties (Table 7). Unvegetated colluvium is undivided and mapped by the Miscellaneous Landscape units Colluvial Rubble (CR) and Talus (T).

Surface form is usually linear and expressed as blankets, veneers, and aprons. It is controlled by the amount of deposition and by the underlying bedrock. Residual material may be sandwiched between colluvium and bedrock. Slopes are commonly are 45 to 100%; their continuity may be broken by one or more bedrock outcrops. Soil creep, snow avalanching, solifluction, and sheet erosion are common modifying processes. Slope failure and cryoturbation occur locally.

Colluvium A

Colluvium A is noncalcareous and coarse textured (Table 7) with abundant, angular, quartzitic coarse fragments. Mappable deposits, associated with the EN3 and TK1 Ecosites, occur near Vermilion Pass and in the East Verdant Creek valley. These were derived from Gog Group quartzites. Localized, unmappable deposits occur in the Brisco and Stanford ranges and are associated with Mount Wilson Formation quartzites. Overall, Colluvium A has limited occurrence and its characteristics (Table 7) are based on BNP and JNP data (Walker *et al.* 1932a). Soils developed in Colluvium A are acidic.

Colluvium B

Colluvium B is non- to weakly calcareous and medium textured (Table 7) with slaty and flaggy coarse fragments. Its principal source in KNP is the extensive, low lime slates of the Chancellor Formation but there are localized occurrences from Glenogle, Miette or McKay slates and shales. Soils developed in Colluvium B are acidic (pH <6.5). Its characteristics, though expanded to include a low lime phase (Walker *et al.* 1982a), are effectively the same as in BNP and JNP. Texturally, the fine earths of Colluvium B derived from Chancellor slates rarely exceed 10% clay content (Fig. 6) and coarse fragment content is lower than described in BNP and JNP. The Fairview (FV), Whitehorn (WH), and Redoubt (RD) Ecosites are geomorphically characterized by Colluvium B landforms. Colluvium B occurs unpredictably on colluvial slopes above the Montane Ecoregion in the Western Ranges and is the subdominant genetic material of the BS2, SB6, SB7, WF5, WF6, and WF8 Ecosites.

Colluvium C

Colluvium C is calcareous and medium textured (Table 7) with abundant, angular to thin, flat coarse fragments of various sizes. It is distributed throughout KNP and was derived from any of the calcareous, medium to fine grained strata. The characteristics of Colluvium C, especially texture (Table 7, Fig. 7), have been modified from the original BNP and JNP definition (Walker *et al.* 1982a) to accommodate a finer textured Colluvium D in KNP. Colluvium C occurs with Colluvium D in southwestern KNP and the distributions in that area are unpredictable. As a general rule, Colluvium C is

Fig. 6. Textural variation among selected samples of Colluvium B and Till B.

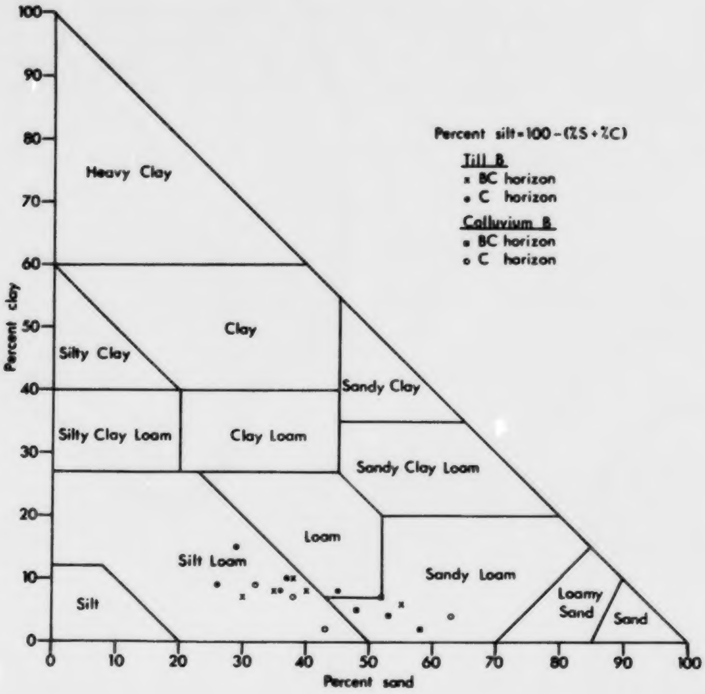
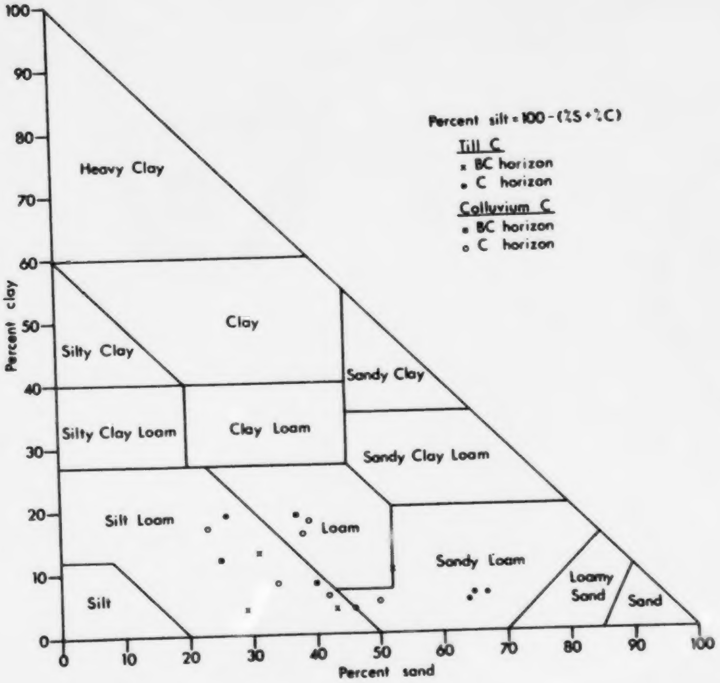


Table 7. Characteristics of colluvial genetic material units.

Genetic Material Unit	Dominant Source	Calcareousness	Textural Properties: Fine Earth	Textural Properties: Coarse Fragments
Colluvium A	Noncalcareous, medium to coarse grained bedrock	Noncalcareous	60-85% sand, 0-10% clay	50-90%
Colluvium B	Non- to weakly calcareous, medium to fine grained, clastic bedrock	<5% $CaCO_3$ equivalent	20-60% sand, 0-20% clay	20-70%
Colluvium C	Medium to fine grained, carbonate and calcareous, clastic bedrock	15-95% $CaCO_3$ equivalent	20-60% sand, 0-20% clay	35-90%
Colluvium D	Calcareous, fine grained, clastic bedrock	5-40% $CaCO_3$ equivalent	10-40% sand, 20-40% clay	20-70%

Fig. 7. Textural variation among selected samples of Colluvium C and Till C.



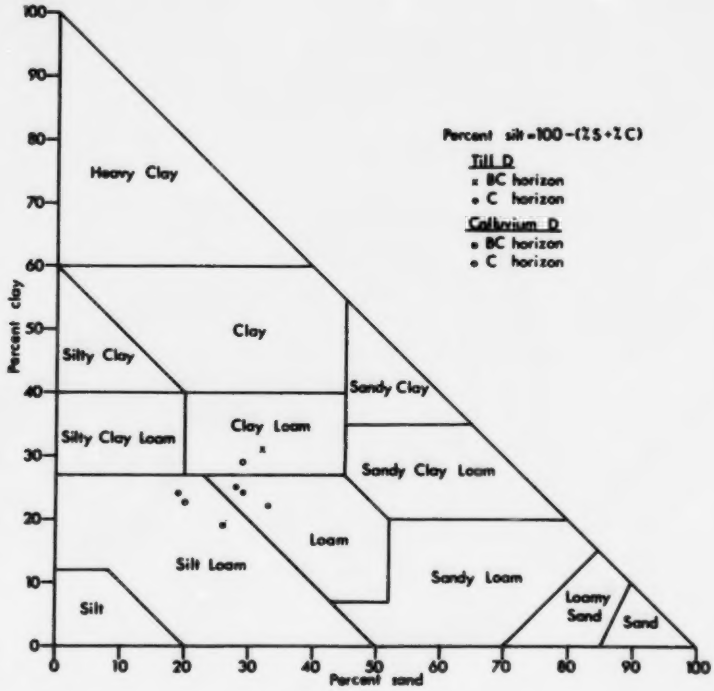
associated with more resistant limestones, Colluvium D with softer clastic rocks. Soils developed in Colluvium C are neutral to alkaline (pH >6.5). The Dry Gulch (DG), Sawback (SB), Wildflower (WF), and Bow Summit (BS) Ecosites are typified by landforms with Colluvium C being the dominant to co-dominant genetic material unit.

Colluvium D

Colluvium D is calcareous and fine textured (Table 7) with slaty, shaly, and flaggy coarse fragments. It occurs in southwestern KNP primarily on slates and shales of the McKay Group. It has higher clay content than Colluvium C and touches on the silt loam, loam, silty clay loam, and clay loam textural classes (Fig. 8). Its calcareousness, reflecting clastic bedrock, ranges lower than that of Colluvium C. Lower sola developed in Colluvium D are medium acid to alkaline (pH >5.5). Lime content is highest and most consistent at lower elevations and becomes more variable at higher elevations.

Because of geologic complexity in the Brisco and Stanford ranges, all four colluvial genetic material units plus intergrades occur. Colluvium A and B occur in small amounts at elevations above the Montane Ecoregion. Colluvium C and D are most abundant but the distributions are unpredictable. Colluvium D is associated with softer clastic rock, Colluvium C with resistant limestones. This geomorphic variability is recognized in the definitions of the appropriate Ecosites (BS2, SB6, SB7, WF5, and WF6). The intergrades are not labelled. Colluvium D and C dominate the landforms of the Dry Gulch (DG) Ecosection.

Fig. 8. Textural variation among selected samples of Colluvium D and Till D.



MORAINAL GENETIC MATERIAL

Moraine (till) is unsorted and unstratified drift deposited by a glacier without reworking by glacial meltwater (Gary *et al.* 1972). It is often associated with ice contact stratified drift along the floors of major valleys. Both are glacial deposits, in contrast with the proglacial materials, glaciofluvial and glaciolacustrine.

Glaciation was a major factor shaping the landscape of KNP. Moraine (M) occurs extensively and frequently dominates lower slopes and benchlands in broad valleys, floors of cirques and cols, valley wall shoulders, and some gently sloping, high elevation, subdued, upper slopes.

Surface form is usually linear on valley wall slopes where morainal material forms blankets and veneers overlying inclined bedrock. The linear slopes are commonly 30 to 70%. Ridged and hummocky surfaces, with complex slopes of 5 to 45%, characterize benchlands, cirques, cols, and shoulders. These hummocky surfaces often reflect underlying bedrock but sometimes reflect deposition, (*e.g.* extinct rock glaciers) or postglacial slope failure. Intergrades between linear and complex topography, *i.e.* ridges superimposed on an incline, are common on upper valley walls. Where the till is shallow, residual material may occur between the till and underlying bedrock. Slope failure, gullying, snow avalanching, solifluction, and sheet erosion commonly modify the surface of morainal landforms. Soil creep and cryoturbation are less evident.

The last major deglaciation in the East Kootenay Region occurred about 15,000 to 10,000 years B.P. (Clague 1975, Ryder 1978, 1981). Source bedrock lithology is more important to textural and chemical properties of morainal material than is glacial chronology (Rutter 1972, Wittneben 1980, Walker *et al.* 1982a). These properties were imparted by the various strata which were mixed by glaciation. However, mixing did not create a homogeneous material and the deposits have been divided into four morainal genetic material units: Tills A, B, C, and D (Table 8). Unvegetated moraine was not divided by lithology and was mapped as the Miscellaneous Landscape Recent Moraine (M). Such moraines usually occur adjacent to existing glaciers and were formed during Neoglaciation (Heusser 1956, Porter and Denton 1967, Gardner 1972).

Till A

Till A is noncalcareous and coarse textured (Table 8) with the highest coarse fragment content (mainly rounded to subrounded quartzites) of the tills. Till A often produces stonier surfaces than other tills. Mappable deposits, associated with the LV2, LV3, and EF1 Ecosites, occur in upper Tokumm and East Verdant Creek valleys and near Vermilion Pass. These were derived from Gog Group quartzites. Localized, unmappable deposits occur in the Brisco and Stanford ranges and are associated with Mount Wilson Formation quartzites. Overall, Till A has limited abundance and its characteristics (Table 8) are based on BNP and JNP data (Walker *et al.* 1982a).

Soils developed in Till A are distinctive in having deeply developed, acidic sola and, where conditions are favorable, thick, well developed, eluvial (Ae) horizons. Lower B or BC horizons may be weakly cemented (duric tendency). Soils on other tills in comparable situations have thinner sola and thinner, weaker Ae horizons, lack the weak cementation, and, except on Till B, are neutral to alkaline.

Till B

Till B is non- to weakly calcareous and medium textured (Table 8) with predominantly slaty and flaggy coarse fragments. Its principal source in KNP was the extensive low lime slates of the Chancellor Formation but there are small, localized occurrences on Glenogle, Miette, and McKay slates and shales. Sola developed in Till B are acidic (pH <6.5). Its characteristics, though expanded slightly to include a low lime phase (Walker *et al.* 1982a), are effectively the same as in BNP and JNP. Texturally, the fine earths of Till B derived from Chancellor slates rarely exceed 15% clay content (Fig. 6). Gullying is less common and severe on Till B than on other tills.

A unique morainal material mapped as JN1F below Sharp Glacier was included with Till B, although it is highly variable and similar to Till A at some sites. This till was derived locally from medium to coarse grained crystalline rocks of the Ice River alkaline complex. Textures are silt loam to loamy sand but coarse fragment content is generally low and the surface and soils have been severely soliflucted. Solifluction is rare on Till A and common on Till B but not to the degree of the JN1F tract. Bedrock underlying this tract is more resistant than normal for Till B areas.

The Cavell (CA), Egypt (EG), Sphinx (SX), and Jonas (JN) Ecosections are characterized geomorphically by Till B landforms. Till B occurs unpredictably in moraines above the Montane Ecoregion in the Western Ranges, where it is the subdominant genetic material unit of the BY6 and PL6 Ecosites. It is also subdominant in the areally limited BY5 Ecosite in the western Main Ranges. A few tracts of CV1 are dominated by Till B.

Till C

Till C is calcareous and medium textured (Table 8) with a variety of coarse fragments. It occurs throughout KNP and was derived from calcareous, medium to fine grained portions of various strata. Textural characteristics (Table 8, Fig. 7) have been modified from the original BNP and JNP definition (Walker *et al.* 1982a) to accommodate a finer textured grouping (Till D) in KNP. Till C occurs

Table 8. Characteristics of morainal genetic material units.

			Textural Properties	
Genetic Material Unit	Dominant Source	Calcareousness	Fine Earth	Coarse Fragments
Till A	Noncalcareous, medium to coarse grained bedrock	noncalcareous	60-90% sand, 0-10% clay	35-70%
Till B	Non- to weakly calcareous, medium to fine grained, clastic bedrock	<5% $CaCO_3$ equivalent	20-60% sand, 5-20% clay	20-50%
Till C	Medium to fine grained, carbonate and calcareous, clastic bedrock	15-85% $CaCO_3$ equivalent	20-60% sand, 5-20% clay	20-50%
Till D	Calcareous, fine grained, clastic bedrock	5-50% $CaCO_3$ equivalent	10-40% sand, 20-40% clay	10-50%

with Till D in southwestern KNP and the distributions are unpredictable. As a general rule, Till C is associated with more resistant limestones and Till D with softer clastic rocks. Lower sola developed in Till C are neutral to alkaline (pH >6.5). The Daer (DR), Bryant (BY), Consolation Valley (CV), and Peyto Lake (PL) Ecosections have glacial landforms in which Till C is an important constituent.

Till D

Till D is calcareous and fine textured (Table 8). It occurs in southwestern KNP and was derived primarily from slates and shales of the McKay Group. Coarse fragments of many sizes and shapes are usually present and include erratics from other more resistant strata. Till D is a fine textured subset of Till C (Table 8, Fig. 8) as originally defined for BNP and JNP (Walker *et al.* 1982a). The areal extent of Till D, reflecting the extensive argillaceous strata in southwestern KNP, necessitated a re-evaluation of the textural limits originally set for Till C. Till D probably correlates with Wycliffe Till and the upper part of Cedrus Till of the East Kootenay Region (Lewis n.d., Kelley and Sprout 1956, Kelley and Holland 1961, Ryder 1981).

The calcareousness range of Till D stretches lower than Till C, reflecting the source clastic bedrock. Consequently, lower sola developed in Till D are usually medium acid to alkaline (pH >5.5), particularly at higher elevations in the Western Ranges. At lower elevations in the main valleys, pH and lime content of Till D are consistently high.

Because of the geologic complexity of the Western Ranges all four morainal genetic material units and intergrades occur. Tills A and B occur is small amounts above the Montane Ecoregion. Tills C and D are most abundant but their distributions are unpredictable. Till D is usually associated with softer clastic rocks and Till C with more resistant limestones. This geomorphic variability is recognized in the definitions of the BY3, BY6, and PL6 Ecosites. The intergrades are not labelled. Till D is a major constituent of the Daer (DR) and Wycliffe (WY) Ecosections.

ICE CONTACT STRATIFIED GENETIC MATERIAL

Ice contact stratified drift (MF^G) is deposited by glacial ice with local reworking by flowing and ponded glacial meltwater. The result is extreme vertical and lateral textural variability over short distances (Plate 1). In essence, it is a random mixture of morainal, glaciofluvial, and, less frequently, glaciolacustrine sediments individually inseparable at a scale of 1:50,000. Ice contact stratified drift and morainal materials are collectively called *glacial* deposits. Two ice contact stratified drift genetic material units (Ice Contact Stratified Drift B and Ice Contact Stratified Drift C) are differentiated primarily on chemical properties (Table 9).

Ice contact stratified drift forms moraine-like landforms on valley floor benchlands and occasionally on lower valley walls. Hummocky, ridged and inclined surfaces are typical. The complex slopes of hummocky and ridged topography commonly are 2 to 45%. These may be depositional, *e.g.* kames, kettles, and eskers, or reflect the underlying bedrock. Inclined slopes, generally 45 to 70%, may reflect underlying bedrock but usually are of erosional origin, being the short, stream-cut scarps that border valley bottomlands. Glaciofluvial terraces too small to map are occasionally included in tracts of ice contact stratified drift. Channelling (*Eroded* modifier, C.S.S.C. 1978a) and gullying are the most important modifying processes, the former often influencing landform surface expression. Other occasional modifying processes include slope failure, snow avalanching, sheet erosion, and soil creep.

Ice Contact Stratified Drift B

Ice Contact Stratified Drift B is calcareous and variably textured (Table 9). It was deposited during the same glacial events as Tills C and D and was derived from the same calcareous bedrock. Textural and chemical characteristics (Table 9) encompass the range of the constituent morainal, glaciofluvial, and glaciolacustrine materials and are the same as described for BNP and JNP (Walker *et al.* 1982a). Coarse fragments vary from virtually nil to >70% by volume and are usually rounded. Gravels, cobbles, and stones occur and, like the fine earths, may be well sorted or unsorted. Calcareousness is sufficiently high that lower sola developed in Ice Contact Stratified Drift B are usually neutral to alkaline (pH >6.5).

Ice Contact Stratified Drift B is a major constituent of the glacial terrain adjacent to the Vermilion, Kootenay, and Columbia rivers within KNP. The Ecosites involved are BY4, BY7, DR5, DR6, DR7, DR8, WY1, and WY2. A CV1 tract near Vermilion Crossing is probably dominated by Ice Contact Stratified Drift B.

The glaciolacustrine constituent of Ice Contact Stratified Drift B is most extensive along the Vermilion River from Marble Canyon to south of the Numa Creek confluence. There, the glaciolacustrine sediment occurs as a veneer or blanket and is very strongly calcareous. It is fine textured (0-10% sand and 30-50% clay) and grades to silty and sandy stratification downwards. These characteristics are similar to those of the Glaciolacustrine genetic material unit described for BNP and JNP (Walker *et al.* 1982a). Unvegetated erosional scars produced by mass movement occur locally along Ochre and Numa creeks (Plate 2) and are associated with glaciolacustrine sediment.

Ice Contact Stratified Drift C

Ice Contact Stratified Drift C is non- to weakly calcareous and variably textured (Table 9). It was deposited as part of the same glacial event that deposited Till B and was derived from the same non- to weakly calcareous clastic bedrock, mainly Chancellor Formation and Miette Group in northern KNP. Walker *et al.* (1982a) describe a variably textured variant of Ice Contact Stratified Drift A (noncalcareous, coarse textured) from three locations in BNP and JNP. Only one of these occurrences included appreciable glaciolacustrine sediment. In KNP, only the variant, here labelled Ice Contact Stratified Drift C, is known to occur. Glaciolacustrine sediment is not a common constituent. Consequently, textural and chemical characteristics (Table 9) reflect those of the constituent morainal and glaciofluvial material.

Coarse fragments vary from virtually nil to over 70% by volume and are usually thin, flat to rounded. Gravels, cobbles, and stones occur and, like the fine earths, may be well sorted or unsorted. Lime content is nil or low and the soils developed in Ice Contact Stratified Drift C are usually acidic (pH <6.5).

Table 9. Characteristics of ice contact stratified drift genetic material units.

Genetic Material Unit	Dominant Source	Calcareousness	Textural Properties	
			Fine Earth	Coarse Fragments
Ice Contact Stratified Drift B	Medium to fine grained, carbonate and calcareous, clastic bedrock	15-85% $CaCO_3$ equivalent	0-100% sand, 0-50% clay	5-70%
Ice Contact Stratified Drift C	Non- to weakly calcareous, medium to fine grained, clastic bedrock	<5% $CaCO_3$ equivalent	20-100% sand, 0-20% clay	5-70%

Glacial landforms with Ice Contact Stratified Drift C occur in Numa, Ochre, and East Verdant creek and Ottertail River valleys, primarily in the CA1 and CA2 Ecosites.

GLACIOFLUVIAL GENETIC MATERIAL

Glaciofluvial (F^G) genetic material is generated by flowing water in which volume and sediment load are strongly affected by melting glacial ice. Deposition occurs where meltwater encounters a valley floor with gentle grade. The sediment overload is rapidly deposited, especially the coarser bedload, producing massive bedding. Much of the silt and clay fractions either remain in suspension or are easily eroded again leaving a deposit with high coarse fragment and sand content. Diurnal fluctuation in summer flow rate also affects aggradation. Ryder (1981) describes glaciofluvial and fluvial processes in the East Kootenay region. McDonald and Banerjee (1971) describe sediments and bed forms from three outwash plains in BNP. Smith (1972) discusses some of these processes occurring at the confluence of Alexandra and North Saskatchewan rivers in BNP. Recent work by Jackson *et al.* (1982) suggests that paraglacial (early postglacial) mud and debris flows contributed significantly to sediment loads.

Glaciofluvial material grades to fluvial material with increasing distance from the glacier as flow fluctuations and sediment load are less influenced by the melting ice. Present streams in KNP show less glacial influence than many streams in BNP and JNP. Lakes such as Floe Lake also attenuate the glacial influence on stream systems. Thus, it is sometimes meaningless in KNP to distinguish between glaciofluvial and fluvial deposits, particularly on valley bottomlands. For example, the recently to currently active landforms of the HD6 Ecosite along the Vermilion and Kootenay rivers may contain glaciofluvial or fluvial sediments. More likely, both occur and there is lateral and vertical gradation from glaciofluvial to fluvial deposits. The HC1 and PP3 Ecosites, although mostly fluvial terrain, also contain some glaciofluvial deposits. Likewise, VL Ecosite tracts may be underlain by glaciofluvial material. The Athabasca (AT) and Bow Valley (BV) Ecosections are characterized by glaciofluvial deposits but may contain some fluvial sediment, most often as a surficial veneer. Ryder (1971) lists greater lithologic variability, greater degree of gravel roundness, better sorting, and the presence of cross, foreset, or horizontal bedding as criteria to distinguish aggradational material of major rivers (***riverine*** deposits) from fan deposits.

The characteristic coarse textures are governed by the depositional environment but the calcareousness still reflects the source. In KNP, only the calcareous deposit, called Glaciofluvial material B (Table 10), is of mappable extent. Noncalcareous Glaciofluvial material A (Walker *et al.* 1982a) is of limited extent and included in Ice Contact Stratified Drift C. Most often, glaciofluvial material is only partially sorted. Where well sorted beds occur, textures may vary beyond the range specified in Table 10. Likewise, coarse fragments, which are mainly rounded gravels, cobbles, and stones, are occasionally sorted and the content range is from zero to about 90%. The calcareousness of Glaciofluvial material B is reflected in soils, most of which have neutral to alkaline (pH >6.5) lower sola.

Table 10. Characteristics of Glaciofluvial material B.

Genetic Material Unit	Dominant Source	Calcareous-ness	Textural Properties	
			Fine Earth	Coarse Fragments
Glaciofluvial material B	Calcareous glacial deposits	>15% $CaCO_3$ equivalent	60-100% sand, 0-5% clay	35-70%

Glaciofluvial material B is distributed along valley bottomlands and, occasionally, adjacent benchlands in the Vermilion and Kootenay river valleys. Terrace is the most common surface form of these stable landforms. Slopes vary, but the majority of any tract consists of linear terraces with <5% slope. Short risers between terraces usually have slopes of 30 to 70%. Actively aggrading glaciofluvial and fluvial deposits bordering streams have level surfaces with slopes commonly <2%. Abandoned channels (*Eroded* modifier, C.S.S.C. 1978a) are usually present on level landforms and less evident on terraces.

FLUVIAL GENETIC MATERIAL

Fluvial (alluvial) material (F) encompasses sediment deposited primarily by nonglacial flowing water and by mud and debris flows, collectively called mudflows. The difference between glacial and nonglacial flow regimes is often indistinct, particularly in a historical sense. Thus, present fluvial systems may have originated in glaciofluvial environments that waned over time. Fluvial landforms may also contain finer textured fluviolacustrine material which fits neither the fluvial nor lacustrine definitions (C.S.S.C. 1978a). Consequently, the materials of fluvial terrain are often complex, particularly in texture. Fluvial landforms are most abundant along valley floors.

Fluvial landforms are of two distinct types. The first is level floodplain, with simple slopes of 0 to 2%, which contain the major streams that formed them. Weak terracing (risers <1 m) occurs on some floodplains. The second consists of fans and aprons, with simple slopes of 2 to 30%, occurring along the base of steeper slopes from which the sediments originated. Radial sections suggest a subtly concave surface with steepest slopes at the apex of fans and aprons and the gentlest slopes at the toe. Linear slopes of many fluvial landforms are broken by active and abandoned channels (*Eroded* modifier, C.S.S.C. 1978a), including narrow elevated ridges along the banks. Polygons mapped with complex slopes contain both types of fluvial landform or fluvial veneers and blankets overlying other deposits.

Floodplain construction differs from that of fans and aprons in that floodplains are constructed exclusively by processes associated with flowing water (Thornbury 1954, Leopold *et al.* 1964, McDonald and Bannerjee 1971, Smith 1972, Ryder 1981). Fans and aprons are constructed by both flowing water and mudflows (Winder 1965, Broscoe and Thomson 1969, Ryder 1971, 1981, Owens 1972, Roed and Wasylyk 1973, Clague 1974, Jackson 1979, Nasmith and Mercer 1979, Rachocki 1981, Jackson *et al.* 1982, Walker *et al.* 1982a). Perhaps the constructional importance of mudflow, also called mass flow (Rachocki 1981), has historically been underestimated. Ryder (1971) estimated that mudflow had generated 40 to nearly 100% of the materials of alluvial fans studied in southcentral British Columbia. Jackson *et al.* (1982) indicate that some fans in the Kananaskis Valley, Alberta, were predominantly the product of mudflows. Construction by mudflows was probably rapid and commenced immediately after deglaciation, a setting called *paraglacial* (Ryder 1971, Jackson *et al.* 1982). In contrast, modern fan and apron surfaces commonly contain streams which occasionally discharge sediment to the landform surfaces during flood. Consequently, the better sorted, frequently shallow, surface deposits are often linked to the activities of modern streams (Broscoe and Thomson 1969, McPherson and Hirst 1972, Roed and Wasylyk 1973) and the underlying mudflow sediments are masked. Although the magnitude of mass movement in fan and apron construction is comparatively insignificant in recent times (Ryder 1971, Roed and Wasylyk 1973, Jackson *et al.* 1982), modern mudflows have occurred (Sharp and Nobles 1953, Winder 1965, Broscoe and Thomson 1969, Jackson 1979, Nasmith and Mercer 1979). Buried volcanic ash layers (Ryder 1971, McPherson and Hirst 1972, Smith 1972, Roed and Wasylyk 1973, Jackson *et al.* 1982), observations on stream channel

Table 11. Characteristics of Fluvial material B.

			Textural Properties	
Genetic Material Unit	**Dominant Source**	**Calcareousness**	**Fine Earth**	**Coarse Fragments**
Fluvial material B	Calcareous, consolidated and unconsolidated deposits	>5% $CaCO_3$ equivalent	10-90% sand, 0-20% clay	0-70%

incisions (Roed and Wasylyk 1973), and soil development (Walker *et al.* 1982a) indicate relative ages of fluvial landform surfaces.

Textural qualities of stream deposits differ from those of mudflow sediments. Stream deposits are moderately to well sorted, vertically stratified and variable across the landscape. Both sand and coarse fragment contents are highly variable. Clasts usually are rounded. By contrast, mudflow beds tend to be unsorted and more uniformly textured with little or no internal stratification because single flow events usually produce each individual bed (Sharp and Nobles 1953, Winder 1965, Ryder 1971, Roed and Wasylyk 1973, Rachocki 1981). Coarse fragments vary in size, shape, and abundance and are usually embedded in a finer grained matrix. The largest debris is often deposited near fan and apron apexes (Sharp and Nobles 1953, Rachocki 1981). Mudflows are strongly influenced by source materials (*e.g.* till and colluvium) and the deposits often resemble till (Sharp and Nobles 1953, Harland *et al.* 1966, Landim and Frakes 1968, Pe and Piper 1975, Ryder 1981). Because of its polygenetic composition and wide range of texture, fluvial material is described here as stratified and coarse-stratified.

Sorting by depositional and erosional processes governs the texture of fluvial material, but source materials strongly influence its chemical properties. Calcareous sediment is most abundant in KNP and is called Fluvial material B (Table 11). Only isolated occurrences of noncalcareous fluvial sediment, similar to Fluvial material A of BNP and JNP (Walker *et al.* 1982a), were found in KNP. Most fluvial deposits in the western Main Ranges are mixtures of calcareous and noncalcareous materials. These deposits have lower than average lime contents, reflected by a wider range of soil development. In KNP, lower sola developed in Fluvial material B range from alkaline to acidic.

FLUVIOLACUSTRINE GENETIC MATERIAL

Fluviolacustrine material (F^L) encompasses fine grained sediments deposited by slowly moving water, both glacial and nonglacial. The depositional environment is low energy fluvial but, by its textural characteristics, fluviolacustrine material does not fit the fluvial definition of C.S.S.C. (1978a). Two fluviolacustrine genetic material units (Fluviolacustrine materials A and B) are differentiated by chemical properties and geomorphic environments (Table 12). No Ecosection or Ecosite separations in KNP are based solely on these units. Both units are described in greater detail by Walker *et al.* (1982a).

Fluviolacustrine material A

Fluviolacustrine material A is the product of sheet erosion which modifies other genetic materials. It is often a mixture of eolian and underlying colluvial, morainal, or fluvial materials. Because of reworking, it tends to be weakly stratified and of finer texture (Table 12) than the original materials. It usually occurs as a thin (<30 cm) veneer overlying morainal and fluvial landforms with slopes of 0 to 30%. As a veneer at the surface of the solum, the original chemical properties such as calcareousness have been pedogenically altered. Likewise, it is often mixed by surficial processes such as solifluction and cryoturbation. Fluviolacustrine material A occurs mostly on the Sphinx (SX) Ecosection.

Table 12. Characteristics of fluviolacustrine genetic material units.

Genetic Material Unit	Dominant Source	Calcareousness	Textural Properties	
			Fine Earth	Coarse Fragments
Fluviolacustrine material A	Localized sheet erosion and deposition on other materials	Pedogenic alteration	0-20% sand, 10-50% clay	<5%
Fluviolacustrine material B	Low energy fluvial deposition	5-70% $CaCO_3$ equivalent	0-20% sand, 10-50% clay	<5%

Fluviolacustrine material B

Fluviolacustrine material B is calcareous, fine-stratified sediment deposited by ponding on backwaters of floodplains (Smith 1972) and on deltaic floodplains at the heads of lakes (Smith 1975). It is the thickest and most stratified of the two fluviolacustrine material units and is common on valley bottomlands where it overlies and interbeds with fluvial and glaciofluvial sediments. Surfaces are level with slopes of 0 to 1%. In KNP, Fluviolacustrine material B occurs on poorly drained landscapes around ponds and lakes (*e.g.* Daer Pond) on the floor of the Kootenay River valley. It is most extensive in the Vermilion Lakes (VL) Ecosection, particularly in VL2. A low lime (1-5% $CaCO_3$ equivalent) variant occurs in KNP.

The lower slopes and toes of some fluvial fans and aprons have fine textured, weakly stratified surficial sediments. These have been deposited by a variety of processes, overlie coarser fluvial materials, and may be either Fluviolacustrine material A or B depending on thickness and pedogenic alteration.

EOLIAN GENETIC MATERIAL

Eolian sediment (E) is deposited by wind. Eolian deposits, also termed *loess*, tend to be well sorted and dominated by silt (rarely <50%). The sand fraction is dominated by fine and very fine sand. Eolian material is widespread, although it rarely exceeds 30 cm in thickness. Two eolian material units occur in BNP and JNP (Walker *et al.* 1982a). Occurrences of the calcareous, medium textured unit (Eolian material A) are very limited in KNP. Small patches of very thin, discontinuous veneer overlie glacial landforms of the Wycliffe (WY) Ecosection on the Columbia River benchland in southwestern KNP. Accretion of this material is probably minimal, presently.

The altered, medium textured eolian material (Eolian material B) is more widely distributed in KNP. Its characteristics (Table 13) are based on data from BNP and JNP (Walker *et al.* 1982a) but no Ecosection/Ecosite separations in KNP were based on its occurrence. Eolian material B occurs as a thin, discontinuous veneer overlying several other materials. It often comprises the upper sola where pedogenic weathering is strongest, hence it is chemically altered. Weathering of the primary minerals, releasing free iron and aluminum oxides, is important to pedogenesis in the Rockies (Pettapiece and Pawluk 1972, Pawluk and Brewer 1975, King and Brewster 1976, Valentine and Lavkulich 1978, Wittneben and Lacelle 1978, Smith 1979, Walker *et al.* 1982c, Smith *et al.* 1983). The ratio of local detritus to volcanic ash in Eolian material B is unknown and varies across the landscape. Several workers describe eolian sediment containing volcanic ash in southeastern British Columbia and southwestern Alberta where it occurs as mineral surface veneers (Westgate and Dreimanis 1967, Beke and Pawluk 1971, Pettapiece 1971, Pettapiece and Pawluk 1972, Knapik *et al.* 1973, Pawluk and Brewer 1975, King and Brewster 1976, Valentine and Lavkulich 1978, Wittneben and Lacelle 1978, Smith 1979, Wittneben 1980, Smith *et al.* 1981, 1983) or as thin layers buried by other materials (Westgate and Dreimanis 1967, Ryder 1971, McPherson and Hirst 1972, Smith 1972, Roed and Wasylyk 1973, Smith 1975, Jackson *et al.* 1982). The ash component has been traced to three major postglacial ashfalls

Table 13. Characteristics of Eolian material B.

Genetic Material Unit	Dominant Source	Calcareousness	Textural Properties	
			Fine Earth	Coarse Fragments
Eolian material B	Local materials and bedrock plus volcanic ash	Pedogenic alteration	0-50% sand, 0-20% clay	<5%

(Powers and Wilcox 1964, Nasmith *et al.* 1967, Westgate and Dreimanis 1967, Harward and Youngberg 1969, Westgate *et al.* 1969): Mazama ash (6600 years B.P.), St. Helens Y (*ca.* 3200 years B.P.) and Bridge River (*ca.* 2400 years B.P.). Mazama ash is the most extensive.

Some authors have generalized by describing thin surface layers of loess (Kelley and Sprout 1956, Wittneben 1980), eolian fines (Ryder 1981), or silty surficial deposit (Coen *et al.* 1977, Smith *et al.* 1981, 1983). This applies to KNP because Eolian material B veneers are less extensive and predictable than in southwestern BNP and JNP (Walker *et al.* 1982a). Occurrences are most consistent in the wind gap area from Luxor Pass to the west face of Mount Shanks. Surface veneers do not have discrete strata comprised of ash or local detritus. Hence, Eolian material B is mineralogically uniform (Smith 1979, Smith *et al.* 1981), its constituents having been mixed by wind, tree throw, soil creep, slope wash, solifluction, and cryoturbation. These processes are common in KNP and the eolian veneer seldom displays an abrupt lower boundary as was frequently observed in BNP and JNP (Walker *et al.* 1982a, c, d). The boundary is often indistinct and eolian material grades, either gradually or in a series of contorted discontinuous layers, to the underlying material. Redeposition of Eolian material B by other processes may alter it sufficiently that the new deposit is classed as another genetic material unit, *e.g.* slope wash, resulting in Fluviolacustrine material A which has a higher clay content and is more stratified than Eolian material B.

ORGANIC, CONSOLIDATED AND ICE COMPONENTS

ORGANIC COMPONENT

The organic component consists of peat with >30% organic matter by weight (>17% organic carbon) that may be as thin as 10 cm over bedrock but is otherwise >40 cm thick (C.S.S.C. 1978a). In KNP, it is of very limited areal extent and thinly mantles (rarely >1.2 m) glacial, fluviolacustrine, and fluvial landforms which have ground water discharge and high water tables (very poor to poor drainage). It consists predominantly of moderately decomposed (mesic) fen peat derived from sedges and brown mosses. In several localities, the fen vegetation has succeeded to open forest. Moderate decomposition of the organic material is characteristic but fibric and humic layers and partially decomposed wood fragments may also occur. The peat is usually medium acid to neutral (pH 5.5-7.5). Fen surface expression is horizontal or sloping and reflects the underlying mineral deposits with slopes from 0 to 10%. Fens occur mostly in CA1, CV1, DR6, DR8, VL2 and VL6 tracts where they are subdominant in the landscape.

CONSOLIDATED COMPONENT (BEDROCK)

The consolidated component (bedrock) consists of tightly packed lithified materials, excluding materials indurated by pedogenic processes, and is harder than 3 on Mohs' hardness scale. Bedrock underlies all other materials, may outcrop in any area, but does so most extensively at high elevations. Massive, resistant bedrock is more prominent in the landscape than recessive bedrock.

Bedrock is the source of all unconsolidated mineral material in KNP except the volcanic component of Eolian material B. For purposes of this ecological land classification, four major lithologic groups are important (Table 4). Although these groups strongly influence the immediate landscape, especially where unsorted sediments are directly derived, bedrock is not subdivided. The Miscellaneous Landscape Rockland (R) is mapped with bedrock as the principal landform, as is the HE2 Ecosite.

ICE COMPONENT

The ice component forms by the compaction and recrystallization of snow that remains year-round. In KNP, it includes glaciers, icefields, glacierettes, and firn. It occurs mainly in the Upper Subalpine and Alpine Ecoregions in the Main Ranges (Falconer *et al.* 1966) and is absent in the Montane Ecoregion and the Western Ranges. In some localities, ice is mantled by colluvial and landslide debris from adjacent steep slopes. The ice component is identified by the Miscellaneous Landscape Glacier (GL).

The Miscellaneous Landscape Rock Glacier (RG) is a mixture of ice and unconsolidated mineral components. A rock glacier is a mass of poorly sorted, angular coarse fragment and fine earth material cemented by interstitial ice a meter or so below the surface (Gary *et al.* 1972).

CHAPTER II - SOILS

B.D. Walker, W.S. Taylor and D.T. Allan

INTRODUCTION

Soil formation is a function of five environmental factors: climate, living organisms, topography, parent material, and time (Buol *et al.* 1973, Brady 1974). The interaction of these factors is complex and the importance of each differs from place to place. Soil forms a continuum with properties varying across the landscape. Soil classifications organize this variability into a useable form. Classifications divide the continuum into groups as defined by certain criteria. Each classification has certain objectives and reflects the knowledge of the soils being classified (C.S.S.C. 1978a). The Canadian system (C.S.S.C. 1978a), used in KNP, is taxonomic in which the taxa are based on soil properties and not on interpretations of the properties for various uses.

Soil taxa are a key element in ecological land classification because they summarize information on both the properties and environment of the pedons. Mapping generalization involves grouping soils into mapping unit concepts and describing these in terms of component taxa. A mapping unit represents a predictable spatial pattern of soil taxa which are related along pedogenic gradients, *e.g.* soils along a seepage slope may be in different taxa but are related along wetness, stability, organic matter, and geomorphic gradients. Thus, the limits of a mapping unit concept are not coincident with those of a soil taxon. The degree of generalization depends on soil complexity and predictability, and on mapping scale.

Much of the published information describing soils in KNP and the surrounding area emphasizes soil distribution. Soil information is available for areas south (Kelley and Sprout 1956), west (Kelley and Holland 1961, Wittneben 1980), north (Coen *et al.* 1977) and northeast (Pettapiece 1971, Walker *et al.* 1978, 1982c, d) of KNP. Manuscript soil maps and legend information for parts of KNP and adjoining areas to the south and east were made available by Lacelle (1982). Wittneben (n.d.), Valentine and Lavkulich (1978), and Wittneben and Lacelle (1978) discuss general soil distribution and development in the East Kootenay Region of British Columbia.

Other relevant soil information is more site specific. Several studies deal with pedons developed within two different geomorphic materials (Beke and Pawluk 1971, Pettapiece and Pawluk 1972, Pawluk and Brewer 1975, King and Brewster 1976, Smith 1979, Smith *et al.* 1981, 1983). Knapik (1972) and Knapik *et al.* (1973) examine soils and soil-plant relationships in the Sunshine area adjacent to KNP. McLean and Holland (1958) discuss general soil-vegetation relations in the upper Columbia valley. Root and Knapik (1972), Lesko and Robson (1975) and Epp (1977) consider soils in relation to trail and campground conditions. Lindsay (1954) examines four soil profiles along the Kootenay and Vermilion rivers in KNP. These illustrate various stages of soil development and currently would be classified in the Regosolic, Brunisolic, and Luvisolic Orders, the latter including profiles with *bisequa* morphologies.

METHODS OF SOIL DESCRIPTION AND ANALYSIS

FIELD DESCRIPTION METHODS

Soil and site data, including geomorphic information, were collected as part of a multidisciplinary, ecological land inventory. Field crews, usually consisting of soils, vegetation, and wildlife specialists, collected data at common sites. Pedon and site data as suggested by Day *et al.* (1975) were recorded on Canadian Soil Information System (CanSIS) computer coding forms (Dumanski *et al.* 1975, C.S.S.C. 1978a, b) developed from the CanSIS Detail Form (Field Description Input Document).

Thirty-eight pedons, representing various soils and characterizing Ecosites and Ecosections, were described in detail on the CanSIS Detail Form and analyzed in the laboratory.

LABORATORY METHODS

Chemical and physical analyses were done following air drying and grinding according to the routine procedures used by the Alberta Institute of Pedology (C.S.S.C. 1978c). Several C.S.S.C. reference samples were included in some analytical procedures to check data quality. Where appropriate, comparisons to tentative ranges and best values, provided by McKeague *et al.* (1978), are made. The routine procedures involved determination of:

Soil Reaction: with a pH meter using a 2:1 ratio of 0.01 M $CaCl_2$ solution to soil (Peech 1965) [3.11].[1]

Total Nitrogen: by a semi-micro version of the Kjeldahl-Wilforth-Gunning method (A.O.A.C. 1955). A mixture of HgO, $CuSO_4$, and K_2SO_4 (Kelpak) was used as a catalyst. Ammonium-N in the distillate was detected with an ammonium ion electrode.

Calcium Carbonate Equivalent: by the inorganic carbon manometric method of Bascombe (1961).

Organic Carbon: by difference between total carbon and inorganic carbon. Total carbon was determined by dry combustion using an induction furnace (Allison *et al.* 1965) with a gasometric detection of evolved CO_2 (Leco model CR12) [3.611]. Results of C.S.S.C. reference samples ranged from the same values to 1.7% higher than the tentative best values reported by McKeague *et al.* (1978).

Cation Exchange Capacity: by displacement of ammonium with sodium chloride (Chapman 1965) except that an ammonium ion electrode was used to detect the displaced ammonium ion. [3.321]

Exchangeable Cations: by extraction with neutral N NH_4OAC (A.O.A.C 1955) and K, Mg, Na, and Ca determined by inductively-coupled plasma spectroscopy [3.321].

Sodium Pyrophosphate Extractable Iron, Aluminum, and Manganese: by the McKeague (1967) method. Determination of Fe, Al, and Mn was done by inductively-coupled plasma spectroscopy [3.53]. Results for C.S.S.C. reference samples were consistently lower than the tentative best values but rarely lower than the range of values reported by McKeague *et al.* (1978).

Particle Size Distribution: by the pipette method of Kilmer and Alexander (1949) as modified by Toogood and Peters (1953), except that carbonates were not removed prior to dispersion. Sand and clay results for C.S.S.C. reference samples ranged from the same values to 3% lower than tentative best values reported by McKeague *et al.* (1978). Separation of sand fractions, by ultrasonic sieving, and coarse fragments, by dry sieving with 3/4 inch and No.4 sieves, was done on some samples to facilitate engineering classification.

Liquid Limit, Plastic Limit, and Plasticity Index: by the ASTM (1970) method [2.61, 2.62, 2.63].

One-third and Fifteen Bar Moisture: by the pressure plate method (U.S. Salinity Laboratory Staff 1954) [2.431].

Bulk Density: by the soil clod method using Saran (C.S.S.C. 1978c). Samples were oven dried and weighed. Calculations were based on air dry volume. Values reported are the arithmetic mean of 1 to 4 determinations per horizon [2.21].

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[1] The number in [ ] indicates the method in C.S.S.C. (1978c).

Results of the above procedures were entered on a CanSIS Detail Form (Methods and Analytical Data) for each pedon. This report also contains descriptions and analytical data for several pedons from BNP and JNP which are characteristic of some soils in KNP. The analytical methods used on BNP and JNP samples (Walker *et al.* 1982c) are effectively the same as those above.

SOILS AND ECOREGIONS

The interactions of the five soil-forming factors have resulted in many different kinds of soils in KNP. Seven of the nine orders in the Canadian System Soil of Classification (C.S.S.C. 1978a) are present, *i.e.* Brunisolic, Chernozemic, Gleysolic, Luvisolic, Organic, Podzolic, and Regosolic. Many great groups, subgroups and phases of these categories are represented.

Soil complexity increases with increasing geologic complexity, as in the Western Ranges, with increasing wetness, and with decreasing landform stability or age (*i.e.* active and recently active geomorphic disturbance). Superimposed on these trends is a subtle increase in soil variability with increasing elevation.

MONTANE ECOREGION SOILS

The Montane Ecoregion is the warmest and driest in KNP. It occurs at the lowest elevations, the upper limits of which decrease northeastwards and converge near Vermilion Crossing. Vegetation is mainly coniferous forest dominated by lodgepole pine (*Pinus contorta*), Douglas fir (*Pseudotsuga menziesii*), and white spruce (*Picea glauca*). Important vegetation of limited areal extent includes sedge fen, wet shrubby meadow, and dry grassland.

Soil parent materials in the Montane are calcareous, with few very localized exceptions, and include glacial (morainal and ice contact stratified drift), fluvial (including fluviolacustrine), glaciofluvial, and colluvial genetic materials. Textures range from coarse to fine. Residuum may underlie some of these materials and thin, silty, eolian veneers sporadically mantle some. Organic materials accumulate in some wet depressions but are of limited areal extent.

UPLAND SOILS OF THE MONTANE

The rapidly to moderately well drained upland soils of the Montane are classed in the Brunisolic, Regosolic, Luvisolic, and Chernozemic orders (C.S.S.C. 1978a). Brunisols are most abundant but often occur in patterns or complexes with members of the other orders. Three major patterns are: Brunisols and Regosols on colluvial landscapes; Brunisols and Luvisols on glacial drift landscapes; and Brunisols, Regosols, and/or Chernozems in the semiarid southwestern corner of KNP. In addition, Brunisols alone characterize stable fluvial and glaciofluvial landforms while Regosols dominate active fluvial and glaciofluvial terrain. Imperfectly drained soils, mainly Gleyed subgroups of the drier soils, are transitional to wetland soils discussed in the succeeding section.

Eutric Brunisols are the dominant and characteristic soils of the Montane Ecoregion in KNP. They occur under a wide range of environmental conditions, being absent or few only where excessive wetness, geomorphic activity or possibly dryness inhibits Brunisolic development. Brunisolic B horizons range from weakly developed, as they intergrade to Regosolic and Chernozemic soils, to moderately developed, as they intergrade to Luvisolic soils. Sola are usually thin, reflecting weak to moderate weathering of highly calcareous materials. Most Eutric Brunisols have little or no eluvial (Ae) horizon and are therefore Orthic Eutric Brunisol. Surface disturbances such as wind throw of trees, sheet erosion, and soil creep are probable causes of this lack of Ae horizon. Absence of an easily weathered eolian veneer, incorporation of humus under the driest conditions, or the presence of fine textured materials may also significantly impede Ae horizon development.

Brunisolic and Regosolic Soils of Fluvial and Glaciofluvial Landscapes

Fluvial and glaciofluvial landforms with old, stable surfaces are dominated by Eutric Brunisols alone. Stability has allowed pedogenic forces to act on the parent material, producing weakly to moderately developed Bm horizons. Luvisols and Brunisols with luvisolic-like Btj horizons occur only infrequently in these landforms. Also, soils with incipient or no B horizons (Regosols) tend to be restricted to sites along active stream channels.

Eluvial (Ae) horizon development varies across these water-laid landforms, as in most other upland landscapes. Orthic Eutric Brunisols, with incipient or no Ae, are usually prevalent over the subdominant Eluviated Eutric Brunisols which have thicker, better expressed Ae horizons. Eluviated Eutric Brunisols are most abundant, becoming codominant with the Orthic members, only on glaciofluvial landforms under moist white spruce-Douglas fir-mixed deciduous forests.

Recent fluvial and glaciofluvial deposits have significantly different soils than landforms with old, stable surfaces. Regosolic soils dominate the recently active landforms because frequent deposition and/or insufficient time have precluded the formation of pedogenic horizons. Under forest vegetation on aprons, fans, and level floodplains bordering streams, the main soils are Orthic or Cumulic Regosols. The latter subgroup applies to soils having buried organo-mineral (Ah) horizons and implies geomorphic stability alternating with fluvial deposition. Orthic and Gleyed Regosols characterize level floodplains and recent terraces along the Kootenay and Vermilion rivers. These soils reflect the moisture gradient of a seasonally varying water table.

Brunisolic-Regosolic Soil Patterns of Colluvial Landscapes

Colluvial landscapes in the Montane are characterized by steep (usually >55%) slopes and calcareous parent materials. Local stability is highly variable and related to kind, intensity, frequency, and areal extent of colluvial or related processes. The geomorphic variability is reflected by intricate Brunisolic-Regosolic soil patterns. Two trends are apparent. First, Orthic Eutric Brunisols tend to be dominant and Orthic Regosols subdominant under closed forest. Secondly, on very steep, rocky terrain under open Douglas fir forest and related subxeric vegetation, Orthic Regosols are dominant with Orthic Eutric Brunisols and Orthic Humic Regosols subdominant. In this latter environment, all soils are lithic (shallow depths to bedrock) and many show humus incorporation in upper horizons.

Regosols occur where recent geomorphic activity has precluded the development of B horizons. Geomorphic disturbance exposes or incorporates fresh calcareous material in the solum and and severely retards soil development. Orthic Regosols have little or no A horizon while Orthic Humic Regosols, common on craggy terrain, probably result from surface disturbances that mechanically incorporate organic material into the topmost 10 cm (or more) of mineral material.

In contrast, Orthic Eutric Brunisols have formed in older, more stable sites even though the lack of well expressed eluvial (Ae) horizon indicates that surface erosion is still important. These soils tend to have weakly to moderately developed Bm horizons, including some with small amounts of lime. Luvisols and Brunisols with luvisolic-like features are virtually absent on colluvial slopes.

Brunisolic-Luvisolic Soil Patterns of Glacial Landscapes

Most glacial landforms in the Montane, excluding the semiarid southwest, are dominated by Eutric Brunisols, predominantly Orthic Eutric Brunisols, with subdominant Orthic Gray Luvisols. The soil pattern on these glacial landforms illustrates the grouping of soil characteristics around the Brunisolic-Luvisolic taxonomic boundary. Brunisolic soils with Bm or Btj horizons are distinguished from Luvisolic soils by the presence of Bt horizons. Recognition of Bt horizons is dependent on moderate or stronger, subangular blocky structure and evident clay films in addition to an increase in clay over the Ae horizon. Even though soils on these glacial landforms fall in two different orders they exhibit a relatively narrow range of characteristics.

A horizon features are another example of the narrow range of characteristics. Soils with incipient or no eluvial (Ae) horizon tend to be prevalent on glacial landforms, particularly if steeply sloping. On steep slopes, shallow erosional processes are important and retard Ae development even though Btj and Bt horizons can still be identified. Weakly eluviated, transitional AB horizons may replace Ae on steep or gentle slopes. Eutric Brunisols with little or no Ae are Orthic Eutric Brunisols. In contrast, there is a trend toward better expression of eluviation in soils of gently to moderately sloping glacial landforms on the benchlands and lower valley walls. Here, most Luvisols and a second subdominant group, Eluviated Eutric Brunisols, have thin LFH horizons overlying weakly expressed, thin (≥2 cm thick) Ae horizons.

Luvisolic and luvisolic-like soils are best expressed on the Kootenay River benchlands and lower valley walls, but even there the Luvisols are subdominant. Luvisolic characteristics become less evident with increasing elevation. They are absent both in the Subalpine, except on glaciolacustrine deposits, and in the Alpine. Where Luvisolic soils occur they are most frequently Orthic Gray Luvisols. However, in protected locations, where little erosion occurs, a veneer of Eolian material B is sometimes evident. The characteristics of this eolian material appear to be conducive to the development of a Bm horizon over the Btj or Bt horizon; the latter are usually developed in the underlying glacial materials. In the situation where the luvisolic B is well expressed, Brunisolic Gray Luvisols are recognized. Examples occur east of Luxor Pass in the Kootenay Crossing area.

Semiarid Soils of Southwestern KNP

The warmest, driest part of the Montane Ecoregion occurs along the southwestern KNP boundary on benchland and lower wall of the Columbia River valley. It lies on the northeastern fringe of a semi-arid area around Lake Windermere in the Rocky Mountain Trench (Marshall n.d., McLean and Holland 1958, Powell 1970). Genetic materials in this area are highly calcareous and mainly glacial with minor amounts of colluvial and fluvial materials. Thin veneers of eolian material, both altered (Eolian material B) and calcareous, are sporadically present. Vegetation is a mixture of Douglas fir closed and open forest plus natural grassland.

Soils under closed forest are Orthic Eutric Brunisols, with very thin sola, high base saturation and pH, and weakly developed Bm horizons without luvisolic tendencies. Very thin organo-mineral (Ah) horizons may be present at the mineral surface.

Soils under grassland and Douglas fir open forest are more complex and their classification is tenuous. On the steepest slopes, where active soil creep and other shallow colluvial processes inhibit pedogenic horizon development, both A and B horizons are generally absent, resulting in Orthic Regosols. Ah horizons of varying thickness and kind have developed on more stable sites. Where these are non-Chernozemic Ah horizons (C.S.S.C. 1978a, Table D35), the soils are Orthic Regosols or Orthic Humic Regosols, depending on Ah thickness. It is likely that Chernozemic Ah horizons also occur, these soils thus being Chernozemics. This conclusion is based on only a few observations and on other studies (Marshall n.d., McLean and Holland 1958, Kelley and Holland 1961, Wittneben 1980) and assumes that mean annual soil temperature is 0°C or higher. The major taxonomic problem is whether the organic carbon to total nitrogen ratio is <17. Assuming the conclusion is correct, most of the Chernozemic soils are Rego Dark Browns because B horizon development is minimal or lacking. Occasionally an Ah-Bmk horizon sequence of sufficient thickness to be classed as Calcareous Dark Brown occurs on gently sloping stable sites such as hummock and ridge crests.

WETLAND SOILS OF THE MONTANE

Wetlands are a small but important part of the Montane Ecoregion. High water tables, surface water collection, and seepage account for the wet soils and vegetation. Many wetlands are too small to map at a scale of 1:50,000 and occur in depressions of glacial landforms as an intergral part of the map unit concept, *e.g.* DR6 Ecosite. Other larger wetlands occur on fluvial and fluviolacustrine materials adjacent to streams and lakes, *e.g.* VL2 Ecosite. Thin organic deposits of moderately decomposed fen peat may mantle the mineral deposits except where there is active fluvial deposition.

Most Montane wetland soils are poorly to very poorly drained. Rego Gleysols are most abundant and may or may not have organic layers at the surface. Organic soils, mainly Terric Mesisols, occur where organic materials exceed 40 cm in thickness. These occupy the wettest, most geomorphically stable sites. Prolonged ponding and fen vegetation, in the absence of mineral material sedimentation, promote the accumulation of peat. The organic material appears to be mostly fen peat derived from sedges and brown mosses. Although mostly moderately decomposed, peat deposits may also contain humic and fibric layers and wood fragments. Peat accumulation seldom exceeds 1.2 m in depth.

Slightly better drained (imperfectly drained) soils are common on parts of some fluvial landforms, *e.g.* HD6 and VL6 Ecosites. These Gleyed Regosols show the effects of seasonal reducing conditions plus recent fluvial aggradation. Other wet or marginally wet soils include Orthic Gleysols and Gleyed Eutric Brunisols. These have limited distribution and generally occur on glacial landforms on transitional sites between depressional wetland and dry upland segments.

SUBALPINE ECOREGION SOILS

The Subalpine Ecoregion occurs above the Montane, is cooler and moister, and extends to the treeless Alpine Ecoregion at 2300 to 2400 m. The Lower Subalpine subdivision extends to approximately 2000 m and is dominated by closed coniferous forests. The Upper Subalpine subdivision is characterized by closed and open coniferous forests at lower elevations and by a pattern of open forest plus heath tundra or herb meadow at higher elevations approaching the Upper Subalpine-Alpine boundary. Other important vegetation groups include shrub and herb complexes produced by snow avalanching.

Soil parent materials in the Subalpine range from noncalcareous to highly calcareous and from coarse to fine textured. Major genetic materials are glacial (morainal and ice contact stratified drift), fluvial, glaciofluvial, and colluvial (including landslide). Residuum often underlies these materials; thin eolian and fluviolacustrine veneers sporadically mantle some landforms. Organic materials accumulate in some wet depressions but are of limited areal extent.

UPLAND SOILS OF THE SUBALPINE

Soils of the Brunisolic order, predominantly the Dystric and Eutric great groups (C.S.S.C. 1978a), characterize the Subalpine Ecoregion. Podzolic, Regosolic and Gleysolic soils occur in lesser amounts. Eutric Brunisols generally have high base status and are weakly acid to alkaline in reaction. They are defined as having a pH ≥ 5.5 to a depth of 25 cm below the top of the B horizon and are associated with calcareous parent materials. Dystric Brunisols are generally acidic soils with low base status and have a pH <5.5 to a depth of 25 cm below the top of the B horizon and are associated with noncalcareous parent materials.

Environmental conditions in the Subalpine promote moderate weathering while parent materials are highly diverse and of variable stability. Thus, individuals typical of both the Eutric and Dystric Brunisol great groups are abundant but so are those with characteristics near the associated taxa boundary. While Eutric Brunisols are associated with calcareous parent materials, *e.g.* in the eastern Main Ranges, similar soils also occur in low lime materials where disturbances such as snow avalanching and shallow colluviation attenuate normal weathering processes. Dystric Brunisols are associated with non- to weakly calcareous, stable, parent materials as in the western Main Ranges. But similar soils occur occasionally in more highly calcareous genetic materials, *e.g.* some fluvial landforms, where a combination of weathering and stability have acidified the sola sufficiently to meet Dystric Brunisol criteria. In the geologically complex Western Ranges, Eutric Brunisols occur in the landscape in an intimate pattern with the less abundant Dystric Brunisols.

Eluviated subgroups (with Ae horizons) or Orthic subgroups (without Ae horizons) occur in Brunisolic soils of either great group. Generally, Orthic Eutric Brunisols are more common than Eluviated Eutric Brunisols on calcareous materials but Eluviated Dystric Brunisols are more common than Orthic Dystric Brunisols on non- to weakly calcareous materials. Variability of Ae development across the landscape seems to be related to slope gradient, calcareousness of parent material, presence of surficial veneers such as Eolian material B, and the age and degree of geomorphic disturbances such as windthrow of trees, soil creep, colluviation, slope wash, solifluction, and snow avalanching. Also, high inputs of humus to surface mineral horizons often mask the morphological evidence of eluviation. For example, humus input under heath tundra in the Upper Subalpine results in Ah, Ahe, or Ah over Ae horizon sequences in upper sola. Under some avalanche v.t.s such as green alder/fern (S13), humus incorporation is high, giving Ah horizons, and evidence of eluviation is usually obscured.

Some Brunisolic soils are transitional to and associated with soils of other orders. These include Regosolic soils on landscapes exhibiting active geomorphic processes, Podzolic soils on stable landforms and gleyed soils under conditions of wetness and seasonal seepage. Brunisolic soils with luvisolic-like morphologies and associated Luvisolic soils are rare in the Subalpine, except on glaciolacustrine material; in contrast with BNP and JNP (Walker *et al.* 1982c).

Weakly Developed Brunisolic and Regosolic Soils

A complex pattern of Brunisolic and Regosolic soils often occurs on steeply sloping (>45%) colluvial landforms. Such soil patterns are the result of varying intensities of colluvial and other surface modification processes, parent material differences influencing horizon development, and time.

Non- to weakly calcareous colluviums (Colluviums A and B) are commonly dominated by Dystric Brunisols, particularly under closed forest where Regosolic soils occur in only minor amounts. On very steep, active, rocky terrain with lithic phase soils under open forest, Orthic Regosols are more common and, along with Orthic Eutric Brunisols, are subdominant to Orthic Dystric Brunisols. On snow avalanche affected terrain, Regosolic soils of both the Humic Regosol and Regosol great groups are codominant with Dystric Brunisols.

Eutric Brunisols and Regosolic soils are usually codominant on landforms consisting of calcareous, medium textured, Colluvium C, regardless of terrain and vegetation. Terrain and vegetation affect only the great group and subgroup assemblages. Orthic and Eluviated Eutric Brunisols and Orthic Regosols tend to be codominant under closed forest. On the other hand, steep rocky terrain under open forest is characterized by lithic phases of Orthic Eutric Brunisols, Orthic Regosols, and Orthic Humic Regosols. Several Regosolic soils along with Eutric Brunisols occur on avalanched terrain. A major exception occurs in the Western Ranges where under similar closed forests (but with an intimate mixture of Colluviums B, C and D) Regosolic soils occur in minor amounts, rather than being codominant.

Only on active or recently active fluvial and glaciofluvial landforms do Regosolic soils dominate in the Subalpine. The main subgroups are Orthic or Cumulic Regosols; Brunisolic soils rarely occur. Cumulic Regosols have buried Ah horizons and imply geomorphic stability alternating with fluvial deposition. Gleyed Regosols are less common but locally important on floodplains with a seasonally varying water table.

Soils of Avalanched Landscapes

Terrain affected by snow avalanching has exceptionally high soil complexity. Soils often differ substantially from site to site and soil patterns vary from avalanche path to avalanche path. The variability reflects differences in avalanche-related geomorphic activity, genetic materials, and organic material incorporation. Most soils are of the Regosolic, Brunisolic, and Podzolic orders.

Regosolic soils dominate sites with frequent and intensive geomorphic activity. Erosional sites occur high in avalanche starting zones and in gully-like channeled tracks and commonly are characterized by Orthic Regosols. Material is deposited downslope, particularly in avalanche runout zones, by colluvial and fluvial processes, including mudflow (Ryder 1981). Depositional sites can have both Orthic and Cumulic Regosols, and Orthic and Cumulic Humic Regosols, depending on organic matter incorporation which results in variable thicknesses of Ah horizons.

Erosion and deposition are negligible on parts of some avalanche paths, especially on unconfined tracks. Brunisolic soils have developed where stability has been of sufficient duration. Usually, Orthic Dystric Brunisols are more abundant on non- to weakly calcareous colluvium, while Orthic Eutric Brunisols predominate on calcareous colluvium. Soils rarely have Ae horizons on avalanched terrain. Soils with Ah horizons are common however, and Orthic Sombric and Melanic Brunisols occur occasionally. At some inactive sites, the sequence of geomorphic events, accumulation of mineral and organic constituents, and weathering have favored development of Podzolic soils. Orthic Humo-Ferric Podzols are subdominant on avalanched, non- to weakly calcareous colluvium (Colluvium B) derived from Chancellor Formation strata. Sombric Humo-Ferric Podzols and Orthic Ferro-Humic Podzols occur infrequently.

Strongly Developed Brunisolic and Podzolic Soils

Soils of the Podzolic order are the most strongly developed soils in KNP. They are common in the Subalpine Ecoregion, although always in association with other soils such as Brunisolics on avalanche slopes or Gleysolics on wetlands. They also occur with Eutric and Dystric Brunisols that dominate well to moderately well drained terrain under forest and heath tundra.

These well drained Podzolic soils are usually Orthic Humo-Ferric Podzols, which have podzolic Bf horizons ≥10 cm thick and contain high amounts (>0.6%) of pyrophosphate-extractable iron and aluminum derived from weathered minerals. Closely related Brunisolic soils have thin (<10 cm) Bf horizons. In the Upper Subalpine-Alpine ecotone, both groups may also have thin Bhf horizons which have high amounts of illuvial-humus as well as iron and aluminum oxides. These Bhf horizons are usually <10 cm thick and overlie Bm or Bf horizons. Orthic Ferro-Humic Podzols (>10 cm Bhf) are not as common in well drained portions of the Upper Subalpine and Alpine as in BNP and JNP (Walker *et al.* 1982c, d). Several soils on the fine textured materials of the Western Ranges have ≥10 cm of well developed B horizons with 0.6% or more pyrophosphate-extractable iron and aluminum. They are classified as Brunisols however, because the high clay content results in ratios of free iron plus aluminum to clay of <0.05 (C.S.S.C. 1978a).

The develoment of Orthic Humo-Ferric Podzols is associated with parent material suitability, geomorphic stability and cool, moist environment. Non- to weakly calcareous parent materials, such as those derived from the Chancellor Formation slates or from Eolian material B, are more readily podzolized. Where the parent materials are calcareous, at least 20 to 30 cm of Eolian material B are necessary for podzolization, since there appears to be little translocation of iron and aluminum oxides across the parent material disconformity to underlying horizons (Beke and Pawluk 1971, King and Brewster 1976, Smith 1979). Geomorphic stability is important because it maintains an intact or minimally disturbed Eolian material B veneer. Thus, Orthic Humo-Ferric Podzols occur on glacial and landslide landforms, particularly those with gentle to moderate slopes and only occasionally on non- to weakly calcareous colluvial slopes or on stable, calcareous fluvial deposits.

Cool, moist environments also appear to promote podzol development and Orthic Humo-Ferric Podzols are most common under Engelmann spruce-subalpine fir (***Picea engelmannii*-*Abies lasiocarpa***) and subalpine larch-subalpine fir (***Larix lyallii*- *Abies lasiocarpa***) forests. Podzolic soils also are associated with impeded drainage and seepage. The principal soils associated with Podzolics are Eutric Brunisols on calcareous materials and Dystric Brunisols on non- to weakly calcareous materials.

WETLAND SOILS OF THE SUBALPINE

Wetlands form a small but important part of the Subalpine Ecoregion in KNP and are due to high water tables and seepage. Three kinds of wetlands occur differing in geomorphology, wetness, and soil and vegetation patterns: Lower Subalpine fluvial, Lower Subalpine glacial, and Upper Subalpine glacial.

Fluvial wetland has imperfectly to poorly drained soils and occurs along streams. Vegetation is highly variable and best represented by wet spruce and spruce-fir open forests. The main soils are Rego Gleysols and Gleyed Cumulic Regosols. Recent mineral deposition has precluded pedogenic horizonation. Gleying is variable and reflects water table fluctuations. Prolonged saturation gives Rego Gleysols. Gleyed Cumulic Regosols occur where saturation periods are shorter or depth to the water table is greater. Rego Gleysols in stable positions often have <40 cm of surficial fen peat.

Most wetland soils on glacial landforms are not presently being affected by erosion or deposition of mineral material. Thus, pedogenic horizon development has occurred in most mineral soils. Additionally, a large proportion of Subalpine glacial wetlands occur in low spots on hummocky and ridged landforms with complex slopes. These are mapped at 1:50,000 as landscape patterns with contrasting dry and wet segments.

Most soils of Lower Subalpine glacial wetlands are poorly to very poorly drained and occur in discharge areas along valley floors and lower slopes that are underlain by Chancellor Formation or Miette Group strata. Vegetation is mainly wet spruce and spruce-fir open forests. The soil pattern is complex and best represented by Orthic Gleysols, Gleyed Ferro-Humic Podzols, and Terric Mesisols. Gleyed Eutric and Gleyed Dystric Brunisols also commonly occur but are of limited areal extent. The Orthic Gleysols and Gleyed Ferro-Humic Podzols are associated with poor drainage, but the B horizon development indicates periods of oxidation in the upper solum. These B horizons range from Bm (Orthic Gleysol) to podzolic Bf, Bhf (Gleyed Ferro-Humic Podzol) or Bh. The presence of eolian, fluvial, and fluviolacustrine veneers that contain primary minerals aids in the development of iron, aluminum, and humus enriched B and podzolic B horizons (usually Bhf and podzolic Bhf). Gleyed Eutric and Gleyed Dystric Brunisols occur on a few, slightly elevated, drier sites within the wetland terrain.

Favorable moisture, nutrient, and vegetation conditions result in the accumulation of fen peat on most Lower Subalpine glacial wetland soils. Terric Mesisols and other Organic soils occur where the peat is >40 cm thick. Such localities are usually the wettest with prolonged saturation and, occasionally, ponding.

Glacial wetlands in the Upper Subalpine are better drained (imperfectly) than those in the Lower Subalpine. Wetness is produced by seasonal seepage and the wetlands occur on floor to lower slope positions in valleys and broad passes. Vegetation includes moist herb meadow, dwarf shrub-herb meadow and herb tundra as well as moist to wet spruce-fir or larch open forests. The soil pattern is complex and contains Gleyed Dystric and Gleyed Sombric Brunisols and Gleyed Ferro-Humic Podzols. Slightly drier soils (Orthic Sombric Brunisols) and wetter soils (Orthic Gleysols) also occur but are of limited areal extent.

Gleying is only moderately to weakly expressed, usually as mottles in middle to lower sola. Consequently, B horizons have developed even though turbic phases, produced by solifluction, are common. B horizons range from Bm (Gleyed Dystric and Sombric Brunisols) to podzolic Bhf (Gleyed Ferro-Humic Podzol). Fluviolacustrine and fluvial veneers that contain primary minerals promote the development of iron, aluminum, and humus enriched B and podzolic B horizons (usually Bhf and podzolic Bhf).

Surface organic layers often occur but are very thin and of different character than the thicker fen peat layers of the Lower Subalpine wetlands. Instead, Ah horizons are common, probably more so than on any Subalpine landscape other than avalanche slopes. Gleyed Sombric Brunisols and the accessory soils, Orthic Sombric Brunisols, have Ah horizons ≥10 cm thick. Eluviation in the form of Ahe or Ae horizons is negligible.

ALPINE ECOREGION SOILS

The treeless Alpine Ecoregion occurs above the Subalpine and has the coldest, harshest climate. Precipitation is high, but the Alpine may not receive the most moisture. Alpine vegetation, dominated by heath, avens, and herb tundras, forms a complex, fine-scale mosaic that reflects microclimatic variations.

Soil parent materials in the Alpine range from noncalcareous to highly calcareous and from coarse to fine textured. Major genetic materials are morainal and colluvial. These materials are often shallow and underlain by residuum. Thin eolian veneers sporadically mantle some landforms. One landscape is characterized by a pattern in which bedrock is dominant and shallow regolith (eolian, morainal, colluvial, and fluvial veneers) is subdominant.

Alpine soils occur in patterns very similar to those of the Subalpine Ecoregion. The main differences are in pattern complexity and A horizon development. As with vegetation, Alpine soils form a complex, fine-scale mosaic. Local differences reflect microclimate, vegetation, slope, genetic material, and geomorphic activity. Colluviation and solifluction are important processes that modify surfaces and turbic phase soils are common.

The main soil patterns are Brunisolic-Regosolic on colluvial and regolithic landforms and Brunisolic > Podzolic on morainal landforms. Similarly, acidic soils, *e.g.* Dystric Brunisols, are associated with non- to weakly calcareous materials; neutral to alkaline soils, *e.g.* Eutric Brunisols, with calcareous materials. However, Ah horizons are more common in the Alpine. Where Ah horizons are ≥ 10 cm soils are Sombric Brunisol (pH <5.5) or Melanic Brunisol (pH >5.5) and are co- or subdominant with Dystric and Eutric Brunisols. Since eluviation is often masked, Orthic subgroups predominate. Only on gently to moderately sloping morainal landforms is eluviation sufficiently expressed that Eluviated Dystric Brunisols become subdominant.

Presence and thickness of Ah horizons also determines the classification of Regosolic soils. Both Orthic Regosols and Orthic Humic Regosols occur, depending on the thickness of this horizon. Thickness variation often reflects influences such as geomorphic activity.

As in the Subalpine, Podzolic soils are among the subdominant group on morainal landforms and of minor importance on some colluvial landforms. They are usually Orthic Humo-Ferric Podzols with podzolic Bf horizons. They may also have thin Bhf horizons above the Bf. Closely related Dystric and Sombric Brunisols have thin Bf or Bhf horizons. The requirements for development of these soils are the same as in the Subalpine. The main difference is that Ae horizons are more weakly expressed often being replaced by Ah or Ahe in the Alpine.

Wetlands are of minor extent in the Alpine and unmappable at the 1:50,000 scale. They occur in depressions on regolithic and morainal landforms and are accessory information in Ecosite descriptions. Wet Alpine soils are usually created by seasonal seepage, exhibit evidence of cryoturbation or solifluction, and are Gleyed subgroups within the Brunisolic and Podzolic orders.

CHAPTER III - VEGETATION

P.L. Achuff and H.A. Dudynsky

INTRODUCTION AND METHODS

FIELD SAMPLING

Since the prime objective of the vegetation study was to provide a vegetation classification for integration into the Ecological Land Classification, the methods were subject to the constraints of the 1:50,000 mapping program. Polygons of homogeneous composition were initially outlined on air photos. Single sample plots (relevés) were then established in homogeneous areas representative of the predominant vegetation of selected polygons. Plots were generally 20 x 20 m in forested vegetation, 15 x 15 m in shrubby vegetation and 10 x 10 m in herbaceous and dwarf shrub vegetation. Smaller plots (5 x 5 m or 1 x 1 m) were sometimes necessary to keep plot boundaries within a homogeneous area, as in some intricately patterned Alpine areas.

Within each plot, canopy cover (Daubenmire 1959) was estimated to the nearest percent both for individual species and for each layer. Plants with <1% cover were considered to have 0.5% cover. Epiphyte cover was not estimated; species were merely noted as being present. Five layers were recognized:

1. Tree layer - woody plants >5 m tall
2. Tall Shrub layer - woody plants 2 to 5 m tall
3. Low Shrub layer - woody plants 0.5 to 2 m tall
4. Herb-Dwarf Shrub layer - woody plants <0.5 m and all herbs regardless of height
5. Bryoid layer - terrestrial bryophytes and lichens.

Cover was also estimated for ground litter, rocks and stones, bare mineral soil, deadfall and water. In forested plots, one of the largest trees was measured for height and diameter at breast height (dbh) and cored to determine its age. Average tree canopy height and the mean and range of dbh were also estimated.

Physical environmental factors noted include: elevation, slope, aspect, topographic position, relief shape, landform, soil subgroup and drainage class. Each plot was also rated on a moisture regime scale (Table 14).

Voucher collections are deposited in the herbaria of: Northern Forest Research Centre (CAFB), University of Alberta (ALTA), Agriculture Canada (DAO) and the National Museum of Canada (CAN). Nomenclature for vascular plants follows primarily Packer (1983) and Hitchcock and Cronquist (1973), for hepatics Stotler and Crandall-Stotler (1977), for mosses Crum *et al.* (1973), and for lichens Hale and Culberson (1970) and Hawksworth *et al.* (1980). A plant species list for KNP is in Appendix A.

VEGETATION CLASSIFICATION

The vegetation was classified initially into five physiognomic (structural) classes: Closed Forest (C), Open Forest (O), Shrub (S), Low Shrub-Herb (L) and Herb-Dwarf Shrub (H). In Closed Forest, the distance between tree crowns is no more than twice the mean crown diameter. This generally corresponds to a lower limit of 15 to 20% tree cover. In Open Forests, the distance between crowns is 2X to 5X mean crown diameter and tree cover is generally between 5% and 15 to 20%. Vegetation with <5% tree cover was not considered forested.

Table 14. Ecological moisture regime classes (Walmsley *et al.* 1980). AWSC=available water storage capacity.

Moisture Regime Class	Soil Drainage
xeric - very dry, little precipitation or high evapotranspiration, very low AWSC	very rapid
subxeric - dry, low AWSC	rapid
mesic - moist, intermediate to high AWSC	well to moderately well
subhygric - moist to wet, variable AWSC, seasonal seepage	imperfect
hygric - wet, variable AWSC, permanent seepage	poor
subhydric - wet, variable AWSC, excess water most of the time	very poor
hydric - very wet, standing water constantly	——

Within these physiognomic classes, the classification was based primarily on the dominant species in each layer (Whittaker 1973a) and on characteristic combinations of species. Dominance or importance was based on cover values and thus, the classification has a quantitative basis. The plots were grouped on the basis of shared characteristics into abstract units called **vegetation types** (v.t.s). V.t.s are viewed as ***noda*** (Poore 1962) along a vegetational gradient or ***coenocline*** (Whittaker 1967). The v.t. is of the same order of magnitude as the ***association*** of the Zurich-Montpellier approach (Westhoff and van der Maarel 1973) or the ***biogeocoenose*** of Sukachev (Sukachev and Dylis 1964), although the bases and methods of recognition differ. V.t.s were delineated by tabular comparison (Mueller-Dombois and Ellenberg 1974) and by both indirect ordination (Wisconsin ordination, Cottam *et al.* 1974) and direct ordination (direct gradient analysis, Whittaker 1973b). Both seral and climax v.t.s were recognized. In v.t. names, a hyphen (-) separates species in the same layer; a virgule (/) separates layers. Appendix E lists the v.t.s of KNP.

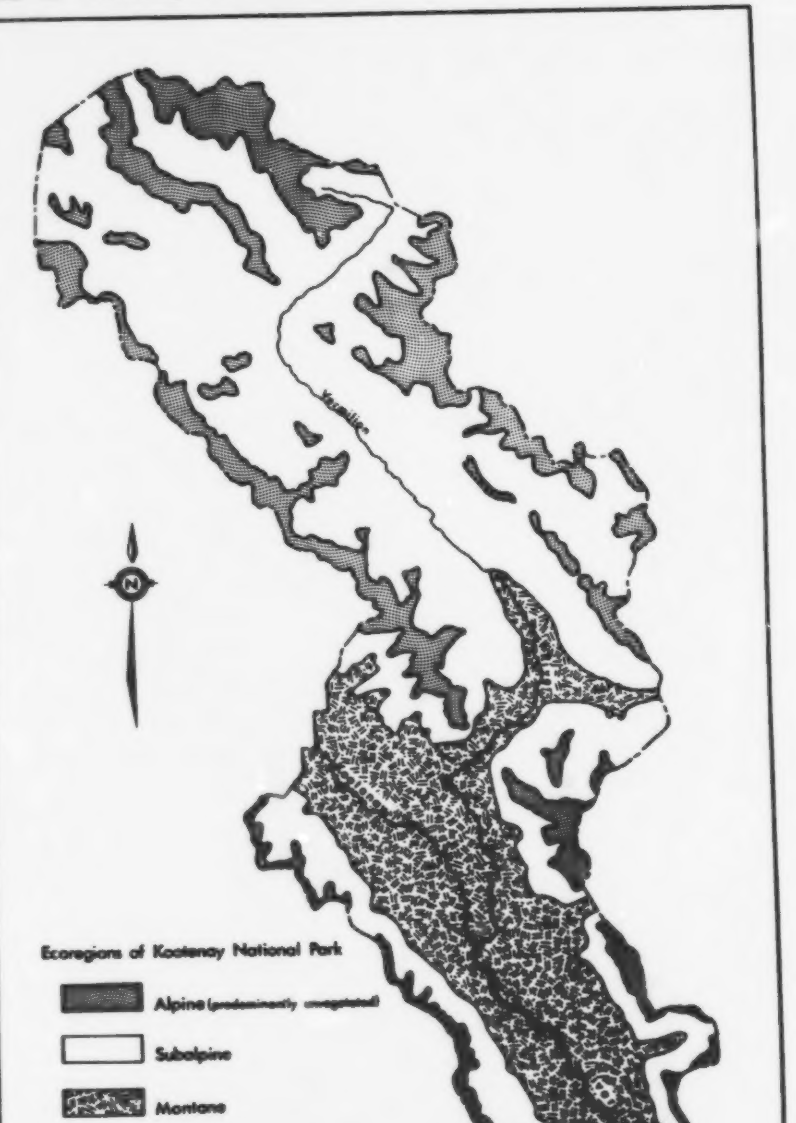
ECOREGIONS

Vegetation is used as the basis for the definition of Ecoregions in the Ecological Land Classification. Ecoregional divisions reflect macroclimate and thus, vegetational features, which primarily reflect climatic factors, rather than, for example, edaphic factors, are used to define Ecoregions. An Ecoregion is conceptually similar to the zone of Daubenmire (1968), La Roi (1975) and Lea (1980, 1983), the biogeoclimatic zone of Krajina (1965) and Utzig *et al.* (1983), the biophysical region of Lacate (1969), and the forest section of Rowe (1972). Three Ecoregions are recognized in KNP: Montane, Subalpine, and Alpine (Fig. 9).

MONTANE ECOREGION

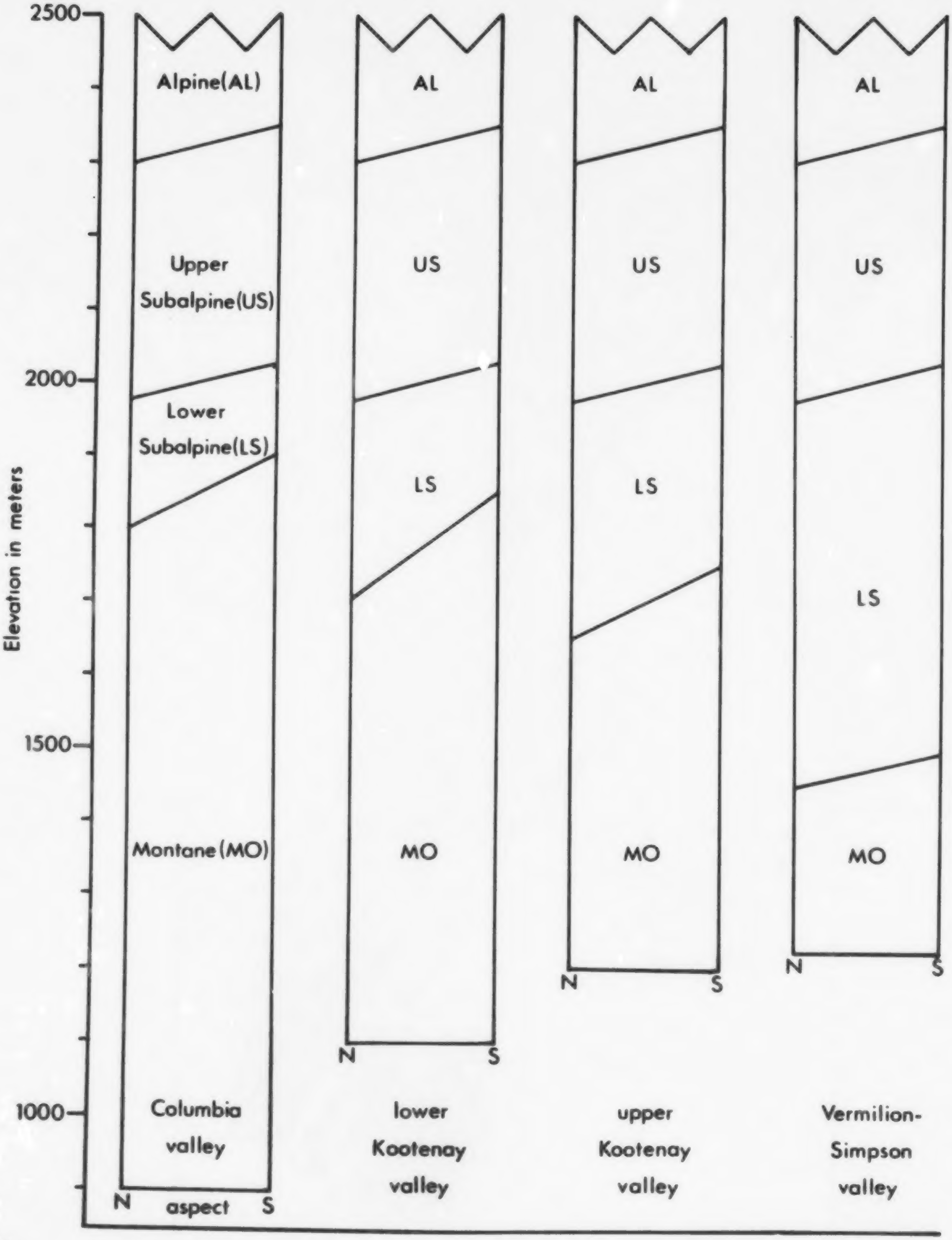
The Montane Ecoregion is characterized by v.t.s dominated by ***Pseudotsuga menziesii*, *Picea glauca*, *Populus tremuloides*** and by grasslands. It occurs from the lowest elevations in the park, at about 1000 m, to various elevations, depending on location and aspect (Fig. 10). The upper boundary is highest in southern KNP and on warm, southerly and westerly aspects, and decreases northward and on cool, northerly and easterly aspects. In the Columbia Valley, the upper boundary is about 1800 m on cool aspects and 1900 m on warm aspects. In the lower Kootenay Valley, the elevations are 1700 m and 1850 m, respectively, while in the upper Kootenay Valley they decrease to 1650 m and 1750 m. At the north end of KNP, in the valleys of the Vermilion and Simpson rivers, the upper boundary is about 1450 m on cool aspects and 1500 m on warm aspects. Typical v.t.s include Douglas fir/hairy wild rye (C1), white spruce-Douglas fir/feathermoss (C5), lodgepole pine/buffaloberry/pine grass (C38), spruce-aspen-lodgepole pine-(paper birch)/buffaloberry/pine grass (C44), Douglas fir/juniper/bearberry (O5) and bluebunch wheatgrass-hairy wild rye-showy aster (H19). Fires have been widespread in this warmest, driest Ecoregion resulting in seral ***Pinus contorta*** forests over much of the area.

Fig. 9. Ecoregions of Kootenay National Park.



Vermilion
N
Ecoregions of Kootenay National Park
Alpine (predominantly unvegetated)
Subalpine
Montane
Scale
0
5
10km

Fig. 10. Elevational ranges of Ecoregions in Kootenay National Park.



The Montane Ecoregion corresponds largely to the Ponderosa pine and Douglas fir Forest Section (M.1) of Rowe (1972), particularly to the Northern Interior Douglas fir portion, which lacks *Pinus ponderosa*. *Pinus ponderosa* occurs in KNP only in the Stoddart Creek area and the vegetation here more closely resembles the Savanna portion (Rowe 1972). The lower Kootenay River valley along Settler's Road is mapped by Rowe (1972) as the Southern Columbia (CL.1) Forest Section. Although it contains some elements of this Section, *e.g.* *Pseudotsuga menziesii*, *Thuja plicata* and *Larix occidentalis*, missing are *Abies grandis*, *Pinus monticola* and, effectively, *Tsuga mertensiana* since <10 trees have been found in KNP. Thus, the occurrence of this Forest Section in KNP is doubtful.

The Survey and Resource Mapping Branch, British Columbia Ministry of Environment has classified the vegetation of the East Kootenay (Lea 1980, 1984) and Purcell (Lea 1983) areas in and adjacent to KNP. The Montane Ecoregion corresponds mostly to the Interior Rocky Mountain Douglas Fir Zone, Lodgepole pine Subzone (IDa), although the Stoddart Creek area more closely resembles the Ponderosa pine Subzone (IDb). The western red cedar/oval leaf blueberry (C42) v.t. and other communities containing *Thuja plicata* resemble the Interior Western Hemlock Zone (IWH), although the zone appears absent in KNP. The upper part of the Montane, where *Picea glauca* is more abundant, probably corresponds to the Interior White Spruce Zone (IWS).

In the biogeoclimatic classification of the British Columbia Ministry of Forests (Utzig *et al.* 1983), the Dry Cordilleran Interior Douglas fir Subzone (IDFg) corresponds to the lower part of the Montane Ecoregion. The Stoddart Creek area is part of the Windermere Lake Variant (IDFg1) in which *Agropyron spicatum* is prominent, while much of the rest of the lower part of the Montane is part of the Kootenay-Columbia Variant (IDFg3) in which *Calamagrostis rubescens* is important. Elements of the Moist Cool Southern Interior Cedar-Hemlock Subzone (ICHc) occur patchily along Sinclair Creek, Vérendrye Creek, and Settler's Road in the lower Kootenay Valley in the western red cedar/oval leaf blueberry (C42) v.t. and other communities containing *Thuja plicata*. The upper part of the Montane corresponds to the lower part of the Dry Cordilleran Montane Spruce Subzone (MSa).

SUBALPINE ECOREGION

The Subalpine Ecoregion occurs at altitudes above the Montane Ecoregion and below the unforested Alpine Ecoregion. The Subalpine Ecoregion is divided into Lower Subalpine and Upper Subalpine portions.

Lower Subalpine

The Lower Subalpine is characterized by closed coniferous forests. Altitudinally, it occurs from the Montane-Subalpine boundary to about 2000 m. The upper boundary to Upper Subalpine is somewhat higher on southerly aspects and somewhat lower on northerly aspects. Mature forest is dominated by *Picea engelmannii* and *Picea glauca*. Introgressive hybrids between *Picea engelmannii* and *Picea glauca* occur in the lower part of the Lower Subalpine. Seral, post-fire *Pinus contorta* forests are also widespread at lower altitudes. Typical v.t.s include Engelmann spruce-subalpine fir/feathermoss (C13), Engelmann spruce-subalpine fir/false azalea (C14), lodgepole pine/false azalea/grouseberry (C20), and Engelmann spruce-subalpine fir/green alder (C25).

The Lower Subalpine corresponds to the lower part of the Interior Subalpine Forest Section (SA.2), although Rowe (1972) recognizes a lower boundary (1100-1220 m) than used here. The Upper Subalpine Engelmann spruce-Alpine fir Zone (SAeS-alF) of Lea (1980, 1983) corresponds to the Subalpine Ecoregion as a whole. The Lower Subalpine corresponds to the Rocky Mountain Douglas fir-lodgepole pine Subzone (SAeA-alFc) and the lower part of the Lodgepole pine-whitebark pine Subzone (SAeS-alFa). In the biogeoclimatic classification (Utzig *et al.* 1983), the upper part of the Dry Southern Cordilleran Montane Spruce Subzone (MSa), corresponds to the lower part of the Lower Subalpine. The Dry Southern Cordilleran Forested Engelmann Spruce-Subalpine Fir Subzone (ESSFa) fits the upper part of the Lower Subalpine.

Upper Subalpine

The Upper Subalpine is broadly ecotonal between Lower Subalpine closed forests and treeless Alpine tundra. Most characteristic are open forests and stunted trees (krummholz). Closed forests do occur in the Upper Subalpine but typically contain Alpine floristic elements, such as ***Phyllodoce empetriformis*** in the Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) and Engelmann spruce-subalpine fir/heather/feathermoss (C34) v.t.s. Also, closed forests usually occur in the lower part of the Upper Subalpine and on warmer, southerly aspects. ***Picea engelmannii*** and ***Abies lasiocarpa*** are characteristic dominants, along with ***Larix lyallii*** and ***Pinus albicaulis***. ***Pinus contorta*** is generally absent. The upper elevational boundary to the Alpine Ecoregion is about 2350 m on southerly aspects and 2300 m on northerly aspects. Typical v.t.s include Engelmann spruce-subalpine fir/grouseberry (C15), Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21), subalpine larch-subalpine fir/grouseberry-everlasting (C23), Engelmann spruce-subalpine fir/heather (O10), and subalpine larch-subalpine fir/heather (O13). Lush herb meadows (fleabane-valerian (H16)) also occur in the Upper Subalpine.

The upper part of the Interior Subalpine Forest Section (SA.2) of Rowe (1972) corresponds to the Upper Subalpine. In the classification of Lea (1980, 1983), the upper part of the Lodgepole pine-whitebark pine Subzone (SAeS-alFa) and the Krummholz-parkland forest Subzone (SAeS-alFb) correspond to the Upper Subalpine. The Upper Subalpine also is equivalent to the Dry Southern Cordilleran Parkland Engelmann Spruce-Subalpine Fir Subzone (ESSFap) of the biogeoclimatic classification (Utzig *et al.* 1983).

ALPINE ECOREGION

The treeless Alpine Ecoregion occurs at altitudes above the Upper Subalpine. Alpine vegetation typically forms a complex, fine-scale mosaic in which microclimatic variations are reflected by marked changes in dominant species. Significant microclimatic factors include aspect, wind exposure, time of snow melt, soil moisture and snow depth. Typical v.t.s include heather-everlasting (L5), arctic willow-cinquefoil (L7), mountain avens-snow willow-moss campion (H1), and everlasting-grouseberry (H17). At the highest altitudes, the saxicolous lichen (H12) v.t. occurs on rocks and shallow soil.

The Alpine Ecoregion corresponds to the Tundra of Rowe (1972), the Alpine tundra Zone (AT) of Lea (1980, 1983), and the Dry Southern Cordilleran Alpine Tundra (ATf) of Utzig *et al.* (1983).

VEGETATION TYPE DESCRIPTIONS

The v.t.s, names and symbols (*e.g.* C1) are part of a system common to BNP, JNP, KNP, MRNP and GNP. All stands of a particular v.t. belong to one conceptual entity and some v.t.s occur in all five parks (*e.g.* H16 and L5) although some occur in only one.

In the stand tables with the v.t. descriptions, stands from outside KNP have been added to better characterize the v.t. where fewer than five stands from KNP were sampled. The additional stands are from adjacent areas in BNP in most cases or occasionally from JNP. Stand numbers between 1001 and 2999 are from KNP. Species with low frequency of occurrence or low cover values have been deleted in many cases from the stand tables. Complete data can be obtained from the authors.

CLOSED FOREST VEGETATION TYPES

C1: *Pseudotsuga menziesii/Elymus innovatus*

(Douglas fir/hairy wild rye)

Environment: C1 occurs on mesic to subxeric Montane sites (1000-1780 m) on moderate to very steep slopes and southerly and westerly aspects in the southern half of KNP, primarily in the Kootenay River, Sinclair Creek, and Columbia River valleys (Plate 17). The soils are well drained Eutric Brunisols and Regosolics on morainal and colluvial landforms.

Vegetation: The tree layer (Table 15) is closed (25-40% cover) and dominated by *Pseudotsuga menziesii* (30-40%). *Pinus contorta* often occurs with low cover. The shrub layer (15-35%) is dominated by *Shepherdia canadensis* (10-20%). *Pseudotsuga menziesii* regeneration (5-10%) is common along with *Juniperus communis* (1-3%), *Amelanchier alnifolia* (1-2%) and *Juniperus scopulorum* (<1%). *Acer glabrum* is sometimes present with 5 to 20% cover, especially along Sinclair Creek. *Calamagrostis rubescens* (10-30%) dominates the herb-dwarf shrub layer (40-65%) as in BNP. Other common species include *Aster conspicuus* (5-15), *Spiraea lucida* (1-5%), *Rosa acicularis* (1-5%), *Linnaea borealis* (1-8%), *Fragaria virginiana* (1-5%) and *Arctostaphylos uva-ursi* (1-5%). Total cover of the bryoid layer is variable, although usually 5 to 25%. *Pleurozium schreberi* (5-35%) is dominant with lesser cover of *Hylocomium splendens*, *Peltigera aphthosa*, *Peltigera canina* and *Dicranum* spp. Epiphytes are in moderate amounts with *Letharia vulpina*, *Hypogymnia physodes*, *Usnea sorediifera* and *Bryoria fuscescens* most common.

C1 is advanced to mature successionally with ages of 100 to 275 years. *Pseudotsuga menziesii* regeneration is present in all size classes indicating a perpetuating tree layer.

Compared with C5, C1 has lower bryoid cover, greater shrub cover and *Picea glauca* is not a co-dominant tree. C1 in KNP differs from that in BNP and JNP in being more mesic, occurring on steeper slopes, having *Pleurozium schreberi* as the dominant bryoid rather than *Hylocomium splendens*, and having greater amounts of *Calamagrostis rubescens* and *Spiraea lucida*.

Other Studies: C1 is also described in BNP and JNP (Corns and Achuff 1982). In British Columbia, similar types are described by Beil (1974, *Pseudotsuga menziesii/Calamagrostis rubescens*), Kuchar (1978, Douglas fir/pine grass-showy aster) in Yoho National Park, Brayshaw (1965, *Pseudotsuga menziesii/Calamagrostis rubescens*, *Pseudotsuga menziesii/Arctostaphylos-Calamagrostis rubescens*), McLean (1970, Tisdale and McLean 1957, McLean and Holland 1958; *Pseudotsuga menziesii/Calamagrostis rubescens*), Kujala (1945, *Pseudotsuga menziesii/Arctostaphylos-Calamagrostis rubescens*) and Lea (1983, Rocky Mountain Douglas-fir-common juniper-wild strawberry-sulphur hedysarum).

In Alberta, C1 is common and is described by La Roi (1975, *Pseudotsuga menziesii/Elymus innovatus/Penstemon procerus/Cetraria islandica*) in JNP, by Stringer and LaRoi (1970) in BNP (*Pseudotsuga menziesii/Calamagrostis rubescens-Elymus innovatus*) and in JNP (*Pseudotsuga menziesii/Elymus innovatus*), Duffey (1971, Douglas fir), Ogilvie (1971, Douglas fir) in the Porcupine Hills, Kondla (1978, Douglas fir/common juniper-buffaloberry, Douglas fir/common juniper) in Kananaskis Provincial Park, and Jacques and Legge (1974, *Pseudotsuga menziesii/Calamagrostis rubescens-Elymus innovatus*) in the Kananaskis area.

C3: *Pinus contorta/Juniperus communis/Arctostaphylos uva-ursi*

(lodgepole pine/juniper/bearberry)

Environment: C3 occurs on mesic to subxeric Montane and Lower Subalpine sites (1110-1910 m) on a variety of slopes and southerly and westerly aspects in southern KNP on lower slopes of the Vermilion and Kootenay river valleys. The soils are well drained Eutric Brunisols on morainal, colluvial, and glaciofluvial landforms.

Table 15. Stands of the Douglas fir/hairy wild rye (C1) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	BB 10 35	HD 20 02	HD 20 31	JD 10 19	MF 20 32	MF 20 45	PA 20 01	PA 20 02	PA 20 03	SD 21 34
TREE LAYER										
Picea glauca	10	--	.5	--	--	01	--	--	--	.5
Pinus contorta	--	--	10	15	05	08	--	--	.5	13
Pseudotsuga menziesii	30	10	20	20	25	35	30	35	40	17
SHRUB LAYER										
Acer glabrum	12	--	12	.5	12	15	--	--	--	13
Juniperus communis	15	--	.5	.5	02	03	--	--	--	07
Juniperus scopulorum	.5	02	--	--	--	.5	03	.5	.5	--
Pseudotsuga menziesii	--	06	02	--	--	05	07	20	10	--
Rosa acicularis	.5	05	08	.5	02	01	01	01	.5	--
Shepherdia canadensis	20	15	35	10	17	35	30	10	10	15
HERB-DWARF SHRUB LAYER										
Achillea millefolium	--	.5	--	--	--	.5	01	.5	--	--
Allium cernuum	02	--	--	.5	--	01	--	--	--	--
Amelanchier alnifolia	--	--	--	.5	--	02	01	.5	.5	--
Antennaria racemosa	10	--	.5	01	--	--	--	.5	--	--
Arctostaphylos uva-ursi	.5	03	--	02	--	--	05	01	01	02
Arnica cordifolia	.5	05	03	05	12	01	15	.5	05	--
Aster ciliolatus	--	--	01	.5	01	.5	.5	--	--	--
Aster conspicuus	05	05	05	25	15	15	--	05	10	02
Berberis repens	--	.5	--	.5	01	01	--	--	--	03
Calamagrostis rubescens	--	55	25	08	28	45	30	25	15	05
Chimaphila umbellata	--	--	01	.5	01	--	--	--	--	02
Clematis verticellaris	03	--	--	--	01	.5	--	--	--	--
Cornus canadensis	03	--	15	--	03	--	--	--	--	--
Fragaria virginiana	01	.5	.5	01	--	01	--	.5	--	02
Galium boreale	--	01	.5	--	--	--	.5	.5	--	--
Hedysarum sulphurescens	--	--	--	.5	01	02	--	.5	--	--
Linnaea borealis	08	--	--	05	06	01	--	--	--	02
Pseudotsuga menziesii	.5	05	.5	--	01	--	.5	--	.5	--
Pyrola secunda	03	--	.5	.5	.5	01	--	--	--	.5
Smilacina racemosa	--	--	--	.5	01	.5	--	--	--	--
Spiraea lucida	01	5	03	01	01	02	03	10	05	01
Thalictrum occidentale	--	--	01	--	--	01	--	--	--	03
BRYOID LAYER										
Dicranum spp.	.5	.5	.5	20	--	--	--	--	--	--
Drepanocladus uncinatus	.5	.5	--	--	5	--	.5	--	.5	--
Hylocomium splendens	--	--	--	--	03	--	.5	01	45	--
Pleurozium schreberi	05	5	5	10	05	01	.5	01	20	.5
Cladonia spp.	5	5	.5	05	.5	5	5	01	.5	--
Peltigera aphthosa	20	5	5	05	02	--	--	--	02	[illegible]
Peltigera canina	05	5	--	5	--	01	--	03	5	[illegible]
EPIPHYTES										
Bryoria spp.	--	.5	.5	--	5	--	.5	.5	.5	--
Cetraria pinastri	--	.5	--	--	.5	--	--	--	.5	--
Hypogymnia physodes	--	--	--	--	--	.5	.5	.5	.5	--
Letharia vulpina	--	.5	.5	.5	.5	.5	.5	.5	.5	.5
Parmeliopsis ambigua	--	.5	--	--	.5	--	.5	--	.5	--
Usnea sorediifera	--	--	--	--	--	--	.5	.5	.5	--

Table 16. Stands of the lodgepole pine/juniper/bearberry (C3) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	HD	HD	HD	JD	JD	JD	SD
	10	11	21	10	10	20	20
	16	19	39	13	14	13	84
TREE LAYER							
Picea glauca	.5	02	05	05	.5	10	05
Pinus contorta	04	06	10	25	16	15	25
Pseudotsuga menziesii	02	--	02	--	08	--	05
SHRUB LAYER							
Juniperus communis	03	04	08	30	60	30	04
Picea glauca	--	02	--	02	01	08	.5
Pinus contorta	01	--	--	--	01	21	--
Shepherdia canadensis	--	.5	07	25	03	10	--
HERB-DWARF SHRUB LAYER							
Achillea millefolium	01	.5	.5	--	--	--	--
Allium cernuum	.5	--	--	--	--	--	.5
Arctostaphylos uva-ursi	07	--	04	05	20	10	01
Arnica cordifolia	01	05	--	02	--	--	--
Aster ciliolatus	.5	02	--	.5	--	--	.5
Aster conspicuus	--	--	--	02	--	--	05
Calamagrostis rubescens	40	--	--	--	10	03	03
Cornus canadensis	--	02	--	--	01	--	.5
Elymus innovatus	--	--	--	--	--	02	.5
Fragaria virginiana	15	03	.5	.5	--	01	.5
Hedysarum sulphurescens	10	--	--	--	.5	.5	--
Linnaea borealis	01	.5	04	15	10	03	02
Pyrola secunda	01	--	--	.5	.5	.5	01
Rosa acicularis	03	--	.5	.5	01	--	01
Spiraea lucida	02	04	--	01	.5	--	--
Vaccinium caespitosum	07	--	--	--	02	05	--
BRYOID LAYER							
Brachythecium spp.	.5	.5	.5	--	--	--	--
Dicranum polysetum	--	--	--	.5	--	01	--
Dicranum scoparium	--	.5	--	--	--	.5	--
Hylocomium splendens	01	--	05	--	85	38	--
Pleurozium schreberi	--	04	--	10	05	42	08
Ptilium crista-castrensis	.5	03	--	--	--	--	--
Tortula ruralis	.5	--	--	--	--	--	02
Cladonia spp.	.5	30	--	.5	--	.5	.5
Peltigera aphthosa	04	01	--	--	--	.5	.5
Peltigera malacea	--	02	--	--	--	.5	.5
EPIPHYTES							
Alectoria sarmentosa ssp. sarmentosa	--	.5	--	--	.5	.5	.5
Cetraria pinastri	--	.5	--	--	--	.5	.5
Hypogymnia physodes	--	.5	--	.5	--	.5	.5
Letharia vulpina	--	--	.5	--	.5	--	.5
Parmeliopsis ambigua	--	--	--	.5	--	.5	.5

Vegetation: The tree layer (Table 16) is sparsely closed (15-35%) and dominated by *Pinus contorta* (10-15%) with lesser amounts of *Picea glauca* (2-5%) and *Pseudotsuga menziesii* (2-5%). The shrub layer is dominated by *Juniperus communis* (5-30%), *Shepherdia canadensis* (5-10%) and *Rosa acicularis* (1-3%). *Arctostaphylos uva-ursi* (10-25%) dominates the herb-dwarf shrub layer, with *Linnaea borealis* (2-10%), *Calamagrostis rubescens* (3-10%) and *Fragaria virginiana* (1-3%) also important. Other characteristic species with low cover include *Pyrola secunda*, *Spiraea lucida*, *Arnica cordifolia* and *Aster ciliolatus*. Bryoid cover is generally low (5-30%) with *Pleurozium schreberi*, *Hylocomium splendens*, *Peltigera aphthosa* and *Cladina* spp. common. Epiphytes are sparse with *Letharia vulpina* and *Alectoria sarmentosa* most common.

Stand age is 125 to 170 years. Since tree regeneration in some stands is mostly *Pinus contorta*, *Pinus contorta* can be considered a climax species on such sites. Thus, C3 is intermediate to mature successionally.

C3 is closely related to C6, C9, C19, C38 and C39 (Table 17) and intergrades occur. C3 is distinguished by having the herb-dwarf shrub layer dominated by *Arctostaphylos uva-ursi* rather than *Aster conspicuus* (C6), *Vaccinium caespitosum* (C9), *Linnaea borealis* (C19), *Calamagrostis rubescens* (C38) or *Cornus canadensis* (C39). C3 also usually has lower *Shepherdia canadensis* cover than C6, C19, C38 or C39.

Other Studies: C3 is also described in BNP and JNP (Corns and Achuff 1982). Vegetation types similar to C3 are described widely from the southern Yukon to northern Wyoming. In British Columbia, Beil (1974) describes a *Pinus contorta/Calamagrostis rubescens* type, Wali and Krajina (1973) a *Cladonio (gracilis)-Arctostaphylo (uvae-ursi)-Vaccinio (myrtilloidis)-Pinetum contortae* type, Brayshaw (1965) a *Pinus contorta/Arctostaphylos-Calamagrostis rubescens* type, Illingworth and Arlidge (1960) a *Pinus contorta/Calamagrostis-Arctostaphylos* type, Kujala (1945) a *Pinus contorta/Calamagrostis-Arctostaphylos* type, Raup (1934) a "dry pine woods" type, Clement (1981) a lodgepole pine-common juniper-pine grass-kinnikinnick type and Lea (1984) a lodgepole pine-soopolallie-pine grass-kinnikinnick type.

La Roi and Hnatiuk (1980) note a *Pinus contorta/Shepherdia canadensis/Arctostaphylos uva-ursi* type in BNP and JNP. Similar types are also described by Hettinger (1975) in JNP (*Pinus contorta* dominated stands of the *Pseudotsuga menziesii/Juniperus communis/Calamagrostis purpurascens* type), La Roi (1975) also in JNP (*Pinus contorta/Juniperus communis/Elymus innovatus/Arctostaphylos uva-ursi/Brachythecium salebrosum* and *Pinus contorta/Shepherdia canadensis/Elymus innovatus/Arctostaphylos uva-ursi*), and in BNP by Trottier and Scotter (1973, *Pinus contorta/Juniperus communis-Arctostaphylos uva-ursi*). In west central Alberta, Corns (1983) describes a *Pinus contorta/Vaccinium myrtilloides/Cladonia* spp. type which corresponds to this concept as do Lesko and Lindsay (1973) in the west central Alberta foothills (lodgepole pine/bearberry). Ogilvie (1976) has a similar *Picea/Arctostaphylos* type and Mackenzie-Grieve (1970) describes similar *Pinus-Populus/Shepherdia-Arctostaphylos* vegetation from the Red Deer River area east of BNP. In central Saskatchewan, Kabzems *et al.* (1976) recognize a *Pinus/Vaccinium vitis-idaea/Pleurozium* type dominated by *Pinus banksiana*.

The northernmost similar type has different understory grasses as in Orloci and Stanek's (1979) *Pinus-Arctostaphylos-Festuca* type in the southern Yukon. Similar types also occur in Wyoming and Idaho (Steele *et al.* 1983, *Pinus contorta/Juniperus communis* type) and from northern Wyoming, Hoffman and Alexander (1976) describe a *Pinus contorta/Arctostaphylos uva-ursi* type.

C5: *Picea glauca-Pseudotsuga menziesii/Hylocomium splendens*

(white spruce-Douglas fir/feathermoss)

Environment: C5 occurs on mesic to subhygric, Montane sites (1100-1730 m) on a wide range of slopes and aspects in the southern half of KNP, especially in the lower Vermilion River, Kootenay River, Sinclair Creek, Stoddart Creek and Columbia River valleys. The soils are well drained Eutric Brunisols on colluvial, morainal, and fluvial landforms.

Table 17. A comparison of seven *Pinus contorta* v.t.s.

Species	C3	C6	C9	C18	C19	C38	C39
Shepherdia canadensis	5-15	15-30	10-30	10-30	10-30	10-40	10-30
Juniperus communis	5-25	1-5	1-3	1-3	1-3	1-5	1-2
Arctostaphylos uva-ursi	10-25	1-3	2-6	1-2	1-3	1-3	<1
Linnaea borealis	2-8	2-5	2-10	3-10	10-40	3-10	1-3
Aster conspicuus	<1	10-20	<1	1-10	1-10	1-5	1-5
Vaccinium scoparium	—	<1	<1*	20-45	—	—	1-4
Calamagrostis rubescens	3-10	5-15	2-10	<1	<1	10-40	2-10
Cornus canadensis	<1	1-3	2-5	1-3	1-3	1-3	10-25
moisture regime	sub-xeric	mesic	mesic	mesic	mesic	mesic	mesic
altitude (m)	1110-1910	1310-1760	1120-1320	1780-1840	1230-1830	1100-1440	1120-1500
tree regen.	***Pinus* > *Picea***	***Picea* > *Pinus***	***Picea***	***Picea* > *Pinus***	***Picea* > *Pinus***	***Picea* > *Pinus***	***Picea* > *Pinus***

****Vaccinium caespitosum*** 10-25%

Vegetation: The tree layer is closed (30-50%) and dominated by ***Pseudotsuga menziesii*** (20-50%) and ***Picea glauca*** (10-25%) with lesser amounts of ***Pinus contorta*** and ***Abies lasiocarpa*** in some stands (Table 18). The shrub layer is sparse (5-15%) with ***Acer glabrum*** (1-5%), ***Shepherdia canadensis*** (3-5%) and ***Amelanchier alnifolia*** (1-3%) most common. The herb-dwarf shrub layer is also usually sparse, but may be occasionally >50%. Dominant species include ***Linnaea borealis*** (1-5%), ***Arnica cordifolia*** (1-5%), ***Cornus canadensis*** (1-3%) and ***Rosa acicularis*** (1-5%). Common species with low cover are ***Spiraea lucida***, ***Pyrola secunda***, ***Calamagrostis rubescens***, ***Lonicera involucrata*** and ***Lonicera utahensis***. The bryoid layer has high cover (50-90%) and is dominated by ***Pleurozium schreberi*** (30-60%) and ***Hylocomium splendens*** (15-50%). Other prominent species are ***Peltigera aphthosa***, ***Ptilium crista-castrensis***, ***Drepanocladus uncinatus*** and ***Cladonia*** spp. Epiphytes are in moderate abundance with ***Hypogymnia physodes***, ***Parmelia sulcata***, ***Letharia vulpina*** and ***Cetraria pinastri*** common.

C5 is advanced to mature successionally with stands 120 to 370 years old. ***Pseudotsuga menziesii*** and ***Picea glauca*** regeneration is common in understory layers. C5 differs from C1 by being on more mesic sites, having less shrub cover and more bryoid cover.

Other Studies: C5 is also described in BNP and JNP (Corns and Achuff 1982). Kuchar (1978) describes a similar white spruce-Douglas fir forest from Yoho National Park in British Columbia.

Table 18. Stands of the white spruce-Douglas fir/feathermoss (C5) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	BB	BB	HD	HD	MF	MF	MF	PA	SD	SD
	10	10	10	20	20	20	20	20	20	20
	02	05	14	39	04	08	18	20	02	12
TREE LAYER										
Picea glauca	25	25	15	12	30	27	26	20	20	20
Pinus contorta	--	--	03	--	--	--	03	15	07	05
Pseudotsuga menziesii	21	25	20	32	30	05	15	25	12	35
SHRUB LAYER										
Abies lasiocarpa	--	01	--	--	--	03	--	--	--	07
Acer glabrum	--	01	--	.5	10	--	--	--	--	.5
Alnus crispa	--	05	.5	.5	05	--	14	--	--	--
Amelanchier alnifolia	--	.5	.5	--	--	03	01	--	.5	.5
Picea glauca	--	--	--	20	04	02	--	17	.5	05
Pseudotsuga menziesii	--	05	--	--	--	--	03	23	02	05
Rosa acicularis	--	--	02	01	--	03	05	.5	13	05
Shepherdia canadensis	--	.5	02	--	--	05	01	05	--	03
HERB-DWARF SHRUB LAYER										
Aralia nudicaulis	--	02	--	.5	--	02	01	--	--	--
Arnica cordifolia	.5	.5	.5	04	--	02	--	02	15	05
Aster conspicuus	--	02	01	.5	--	02	03	--	--	.5
Berberis repens	--	.5	--	--	--	--	09	--	--	.5
Calamagrostis rubescens	--	.5	01	--	--	--	05	01	05	35
Clematis verticellaris	.5	.5	--	--	02	.5	--	--	--	--
Cornus canadensis	--	01	02	01	--	05	07	01	20	--
Goodyera repens	.5	--	.5	--	.5	.5	--	--	--	--
Linnaea borealis	.5	01	02	.5	03	06	05	01	10	05
Lonicera involucrata	.5	.5	.5	--	--	02	--	02	--	--
Lonicera utahensis	--	04	--	--	--	--	.5	.5	03	.5
Mitella nuda	--	.5	.5	--	--	--	--	01	.5	--
Pyrola secunda	.5	--	.5	.5	.5	01	--	.5	--	--
Pyrola virens	--	.5	.5	--	--	--	--	.5	.5	.5
Rubus pubescens	--	--	--	--	--	03	--	02	03	--
Smilacina racemosa	.5	.5	--	--	02	--	--	--	.5	.5
Spiraea lucida	--	.5	01	02	--	.5	01	5	--	--
Symphoricarpos albus	--	--	--	--	--	05	--	.5	07	01
BRYOID LAYER										
Brachythecium spp.	.5	01	.5	--	--	--	--	.5	--	.5
Dicranum spp.	.5	.5	.5	03	01	--	01	02	.5	.5
Drepanocladus uncinatus	.5	.5	.5	02	--	--	--	.5	.5	--
Hylocomium splendens	40	15	--	--	68	30	29	15	50	35
Pleurozium schreberi	40	40	40	05	04	30	40	60	35	03
Ptilium crista-castrensis	.5	05	--	--	--	--	--	03	04	02
Timmia austriaca	05	.5	.5	--	01	--	--	--	--	--
Ptilidium pulcherrimum	--	.5	.5	--	--	.5	--	.5	.5	.5
Cladonia spp.	.5	--	.5	--	--	.5	--	--	.5	.5
EPIPHYTES										
Alectoria sarmentosa ssp. sarmentosa	.5	--	--	.5	--	--	--	.5	--	.5
Bryoria spp.	.5	--	--	--	--	.5	--	.5	--	.5
Cetraria spp.	.5	.5	.5	--	--	.5	--	.5	--	.5
Hypogymnia physodes	.5	.5	.5	--	--	.5	.5	.5	.5	.5
Parmelia sulcata	.5	--	--	--	.5	.5	.5	--	--	.5
Parmeliopsis ambigua	--	.5	.5	--	--	--	--	.5	--	.5
Usnea spp.	.5	.5	--	--	.5	.5	.5	--	--	-

C6: *Pinus contorta/Shepherdia canadensis/Aster conspicuus*

(lodgepole pine/buffaloberry/showy aster)

Environment: C6 occurs on mesic Montane to Lower Subalpine sites (1310-1760 m) on moderate to steep slopes and southerly aspects (Plate 49). The soils are well drained Eutric Brunisols on colluvial, morainal, and glaciofluvial landforms.

Vegetation: The closed tree layer (Table 19) is dominated by *Pinus contorta* (20-70%) The shrub layer is moderately dense (10-30%) and dominated by *Shepherdia canadensis* (15-30%). *Amelanchier alnifolia* and *Rosa acicularis* are common. The well developed herb-dwarf shrub layer (25-60%) is dominated by *Aster conspicuus* (10-20%). Other common species include *Aster ciliolatus* (5-25%), *Linnaea borealis* (2-5%), *Calamagrostis rubescens* (2-10%) and *Arnica cordifolia* (1-4%). Commonly present with low cover are *Fragaria virginiana*, *Lonicera utahensis*, *Pyrola secunda*, *Spiraea lucida* and *Epilobium angustifolium*. Total cover of the bryoid layer is 25 to 50% with *Pleurozium schreberi* (10-20%) dominant. Other common species are *Drepanocladus uncinatus*, *Hylocomium splendens*, *Cladonia ecmocyna* and *Peltigera aphthosa*. Epiphytes are scarce with *Letharia vulpina* and *Parmeliopsis ambigua* common.

C6 is intermediate to advanced successionally with stands 90 to 170 years old. Succession to C37 or perhaps C13 seems likely. C6 is closely related to C3, C9, C18, C19, C38 and C39 and intergrading stands occur (Table 17). C6 differs in having the herb-dwarf shrub layer dominated by *Aster conspicuus* rather than *Arctostaphylos uva-ursi* (C3), *Vaccinium scoparium* (C18), *Linnaea borealis* (C19), *Calamagrostis rubescens* (C38) or *Cornus canadensis* (C39).

Other Studies: C6 is also described in BNP and JNP (Corns and Achuff 1982). Similar types are described in British Columbia by Kuchar (1978, lodgepole pine/buffaloberry/pinegrass) in Yoho National Park, by Tisdale and McLean (1957, *Pinus/Calamagrostis*) in central British Columbia, by Lea (1984, lodgepole pine-soopolallie-showy aster-Indian paintbrush), and by Illingworth and Arlidge (1960, *Pinus contorta/- Calamagrostis*) in south central British Columbia. In JNP, La Roi (1975) describes a similar *Pinus contorta/Shepherdia canadensis/Rosa acicularis/Arnica cordifolia/Linnaea borealis/Pleurozium schreberi* type and Hettinger (1975) describes similar vegetation as seral to a *Pseudotsuga menziesii/Elymus innovatus* type. In BNP and JNP, La Roi and Hnatiuk (1980) have a similar *Pinus contorta/Shepherdia canadensis/Elymus innovatus* type and in BNP, Ogilvie (1976) notes a pine dominated *Picea-Abies/Calamagrostis* type. Elsewhere in Alberta, similar types are described by Kirby and Ogilvie (1969, young *Pinus contorta/Hylocomium-Cornus*) and by Kondla (1978, pine/buffaloberry/feathermoss) both in the Kananaskis area. Cormack (1953) in the southern foothills describes similar forests as seral to spruce-fir climax.

C9: *Pinus contorta/Vaccinium caespitosum*

(lodgepole pine/dwarf bilberry)

Environment: C9 occurs on mesic Montane sites (1120-1320 m) on gentle slopes and various aspects in the middle part of the Kootenay River valley. The soils are well drained Eutric Brunisols on fluvial landforms.

Vegetation: The tree layer (Table 20) is closed (15-40%) and dominated by *Pinus contorta* (15-35%) with *Picea glauca* (2-5%) often present. Total shrub layer cover is 25 to 35% and *Shepherdia canadensis* (20-35%) is dominant. *Amelanchier alnifolia* and *Juniperus communis* are often also present. The herb-dwarf shrub layer (15-70%) is dominated by *Vaccinium caespitosum* (2-3%) and *Cornus canadensis* (2-5%). Species with low cover but high frequency are *Fragaria virginiana*, *Aster conspicuus*, *Arnica cordifolia*, *Pyrola secunda* and *Spiraea lucida*. Bryoid layer total cover is 15 to 85% with *Pleurozium schreberi* (30-85%) and *Hylocomium splendens* (20-35%) dominant. Epiphytes are moderate with *Alectoria* spp. and *Bryoria* spp. most common.

Stands are 60 to 116 years old and intermediate successionally with *Picea glauca* regeneration common in the understory. C9 is related to C3, C6, C18, C19, C38 and C39 (Table 17). It is distinguished primarily by the dominance of *Vaccinium caespitosum* in the herb-dwarf shrub layer.

Table 19. Stands of the lodgepole pine/buffaloberry/showy aster (C6) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	HD	JD	MF	MF	SD	SD
	11	10	20	20	20	21
	16	02	34	64	83	40
TREE LAYER						
Picea engelmannii	--	.5	--	--	05	15
Pinus contorta	25	25	70	80	35	22
SHRUB LAYER						
Abies lasiocarpa	--	01	--	--	02	12
Amelanchier alnifolia	--	03	--	01	--	01
Juniperus communis	04	01	--	--	03	--
Lonicera utahensis	01	.5	.5	35	--	--
Pinus contorta	.5	.5	03	--	.5	--
Shepherdia canadensis	30	08	08	05	05	03
HERB-DWARF SHRUB LAYER						
Arctostaphylos uva-ursi	.5	01	--	--	02	--
Arnica cordifolia	--	.5	20	01	--	04
Aster ciliolatus	.5	01	--	--	--	--
Aster conspicuus	25	30	23	03	08	05
Calamagrostis rubescens	02	10	--	02	02	.5
Cornus canadensis	--	--	--	01	--	03
Epilobium angustifolium	--	.5	--	.5	.5	--
Fragaria virginiana	05	01	--	--	02	02
Linnaea borealis	04	05	09	02	05	.5
Pyrola secunda	--	--	02	.5	02	.5
Rosa acicularis	--	--	--	04	03	--
Rubus parviflorus	--	.5	--	02	--	--
Spiraea lucida	--	02	02	02	.5	--
Stenanthium occidentale	--	--	03	.5	.5	--
Thalictrum occidentale	--	--	--	.5	--	.5
Vaccinium scoparium	10	05	--	--	--	02
BRYOID LAYER						
Dicranum spp.	.5	30	02	--	05	02
Ditrichum flexicaule	--	.5	03	--	--	--
Drepanocladus uncinatus	--	--	.5	.5	--	.5
Hylocomium splendens	--	03	20	--	--	10
Pleurozium schreberi	10	25	20	21	10	15
Pohlia nutans	--	--	.5	--	--	.5
Ptilium crista-castrensis	05	05	--	--	--	10
Cladonia ecmocyna	--	08	.5	.5	.5	.5
Cladonia spp.	.5	02	.5	.5	--	.5
Peltigera aphthosa	--	.5	05	--	--	.5
EPIPHYTES						
Bryoria spp.	--	.5	.5	.5	--	.5
Hypogymnia spp.	--	.5	.5	--	--	.5
Letharia vulpina	.5	.5	.5	--	.5	--
Parmeliopsis ambigua	--	.5	.5	.5	--	.5
Parmeliopsis hyperopta	--	--	.5	.5	--	--

Other Studies: C9 is also described in BNP and JNP (Corns and Achuff 1982). In British Columbia, Lea (1984, lodgepole pine-birch-leaved spirea-pine grass-dwarf blueberry) has a similar type from the East Kootenays. Similar Alberta forests are described by Ogilvie (1963, *Pinus contorta/Calamagrostis rubescens-Vaccinium*) in BNP, and by Mackenzie-Grieve (1970, *Pinus-Picea/Vaccinium caespitosum-Vaccinium vitis-idaea/Hylocomium* and *Pinus-Picea/Shepherdia-Vaccinium/Hylocomium*) for

Table 20. Stands of the lodgepole pine/dwarf bilberry (C9) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	HD	MF	MF	PA	AW	AW
	20	20	20	10	50	50
	11	12	14	03	53	57
TREE LAYER						
Picea glauca	02	05	--	06	--	--
Pinus contorta	15	55	38	35	35	35
SHRUB LAYER						
Alnus crispa	--	01	02	--	--	--
Juniperus communis	--	--	08	01	01	04
Ledum groenlandicum	--	10	--	.5	01	04
Picea glauca	02	11	--	10	04	04
Pinus contorta	.5	.5	.5	--	--	--
Salix scouleriana	--	.5	--	02	--	--
Shepherdia canadensis	.5	52	21	33	07	08
HERB-DWARF SHRUB LAYER						
Achillea millefolium	.5	--	01	--	.5	.5
Amelanchier alnifolia	--	05	.5	.5	--	--
Arctostaphylos uva-ursi	01	--	10	--	01	08
Arnica cordifolia	--	01	.5	.5	01	01
Aster ciliolatus	--	--	.5	.5	--	04
Aster conspicuus	--	01	02	.5	.5	--
Calamagrostis rubescens	40	.5	08	02	--	--
Cornus canadensis	05	02	--	05	09	05
Elymus innovatus	--	08	16	.5	03	04
Epilobium angustifolium	--	01	--	.5	.5	.5
Fragaria virginiana	05	--	01	01	--	03
Linnaea borealis	.5	01	10	02	04	21
Oryzopsis asperifolia	--	--	04	01	.5	04
Pyrola secunda	02	01	.5	--	--	--
Rosa acicularis	03	02	03	03	02	02
Rubus pubescens	--	01	--	.5	--	--
Spiraea lucida	--	04	01	.5	--	--
Vaccinium caespitosum	10	15	12	.5	23	25
Lycopodium annotinum	--	04	01	.5	--	--
BRYOID LAYER						
Hylocomium splendens	--	35	--	30	--	--
Pleurozium schreberi	85	28	15	30	25	06
Ptilium crista-castrensis	--	--	--	25	--	--
Cladonia spp.	--	--	.5	--	--	01
Peltigera aphthosa	--	02	--	--	30	02
EPIPHYTES						
Bryoria fremontii	--	--	--	.5	--	--
Alectoria sarmentosa ssp. sarmentosa	--	--	.5	--	--	--
Bryoria fuscescens	--	--	.5	--	--	--
Cetraria pinastri	--	--	--	.5	--	--
Parmeliopsis ambigua	--	--	--	.5	--	--

the Red Deer River area east of BNP. Pfister *et al.* (1977) describe similar forests as seral stages of the *Picea/Vaccinium caespitosum* and *Abies lasiocarpa/Vaccinium caespitosum* types as well as the drier *Pinus contorta/Vaccinium caespitosum* type.

C10: *Pinus contorta/Alnus crispa/Hylocomium splendens*

(lodgepole pine/green alder/feathermoss)

Environment: C10 occurs in the Vermilion and Kootenay river valleys on mesic Montane and Lower Subalpine sites (1310-1810 m) on all aspects and gentle to steep slopes. The soils are well drained Eutric Brunisols developed on morainal and colluvial landforms.

Vegetation: The tree layer (15-55%) is dominated by *Pinus contorta* (10-50%) (Table 21). *Picea glauca* (1-10%) is often present as well. *Alnus crispa* (10-60%) dominates the shrub layer (15-80%). *Shepherdia canadensis*, *Menziesia glabella* and *Salix scouleriana* occur sporadically with ≤15% cover. Total herb-dwarf shrub layer cover is 30 to 85% with *Arnica cordifolia* (1-15%), *Cornus canadensis* (1-5%), *Aster conspicuus* (1-10%), *Linnaea borealis* (1-3%) and *Spiraea lucida* (1-3%) most common. Also often present with low cover are *Epilobium angustifolium*, *Fragaria virginiana*, *Pyrola secunda*, *Rubus parviflorus* and *Rosa acicularis*. The bryoid layer (15-70%) is usually dominated by *Pleurozium schreberi* (10-55%), rather than *Hylocomium splendens* as in BNP and JNP. Other common species include *Peltigera aphthosa* (1-5%), *Dicranum fuscescens*, *Pohlia nutans*, *Hylocomium splendens* and *Cladonia* spp. Epiphytes are generally scarce with *Parmeliopsis ambigua*, *Bryoria fuscescens*, *Cetraria pinastri*, *Letharia vulpina*, *Hypogymnia imshaugii* and *Hypogymnia physodes* commonly occurring.

C10 is intermediate successionally with stands 55 to 140 years old. Succession to C25 appears likely. C10 is distinguished from other *Pinus contorta* v.t.s by the dominance of *Alnus crispa* in the shrub layer.

Other Studies: C10 is also described in BNP and JNP (Corns and Achuff 1982). In the East Kootenays of British Columbia, Lea (1984) has a similar lodgepole pine-thinleaved alder-soopolallie-northern twinflower type and in northeastern British Columbia, Raup (1934) describes "rich pine woods" which have much *Alnus crispa* in the understory. La Roi and Hnatiuk (1980) report a *Pinus contorta/Alnus crispa/Linnaea borealis* type in BNP and JNP and La Roi (1975) has a *Pinus contorta/Alnus crispa* type in JNP. In west central Alberta, Corns (1983) describes *Pinus contorta/Alnus crispa/Cornus canadensis*. Similar types are also described in the northern foothills by Corns (1978) and Corns and La Roi (1976). Further south, Jacques and Legge (1974, *Picea/Alnus crispa-Aster conspicuus*) in the Kananaskis area and Ogilvie (1963, *Pinus/Hylocomium-Alnus*) also have similar types. Mackenzie-Grieve (1970) describes several similar types in the Red Deer River valley east of Banff (*Picea-Pinus/Hylocomium*, *Pinus-Picea/Alnus/Hylocomium*, *Pinus-Picea/Hylocomium*, *Pinus/Alnus/Aster* and *Pinus-Populus/Alnus/Elymus*). Pfister *et al.* (1977), in Montana, describe similar *Pinus contorta* dominated seral stands of the *Abies lasiocarpa/Alnus sinuata* type.

C11: *Pinus contorta-Picea* spp./*Hylocomium splendens*

(lodgepole pine/feathermoss)

Environment: C11 occurs in the Kootenay and Vermilion river valleys on mesic Montane (1210-1670 m) sites on gentle slopes of various aspect. The soils are well drained Eutric Brunisols developed on fluvial landforms.

Vegetation: *Pinus contorta* (20-30%) dominates the closed tree layer (20-45%) with *Picea glauca* (3-10%) usually present also (Table 22). The shrub layer is sparse (≤15%) with *Picea glauca* regeneration (1-5%) most common. The herb-dwarf shrub layer is also sparse with total cover generally ≤20%. *Cornus canadensis* (2-5%) and *Rosa acicularis* (1-2%) are most common, while *Pyrola secunda*, *Spiraea lucida*, *Linnaea borealis*, *Fragaria virginiana*, *Aster conspicuus* and *Viburnum edule* occur frequently but with low cover. The bryoid layer is well developed (65-90%) and dominated by *Pleurozium schreberi* (30-75%), with lesser amounts of *Hylocomium splendens* (10-35%), *Ptilium crista-castrensis* (15-40%), *Peltigera aphthosa* (5-10%), *Dicranum scoparium* (<1%) and *Cladonia* spp. (<1%). Epiphytes are scarce with *Hypogymnia physodes* and *Letharia vulpina* most frequent.

Stand ages are 65 to 140 years. C11 is intermediate to advanced successionally since *Picea* spp. regeneration is common in the understory. Succession to C13 seems likely. C11 is distinguished from

Table 21. Stands of the lodgepole pine/green alder/feathermoss (C10) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	BB	HD	HD	JD	MF	MF	MF	PA	PA	PA
	10	10	20	10	20	20	20	10	20	20
	30	41	66	04	27	29	49	69	18	26
TREE LAYER										
Abies lasiocarpa	.5	.5	--	.5	--	--	--	--	--	08
Picea glauca	--	01	02	05	--	02	10	.5	--	02
Pinus contorta	50	12	33	30	50	58	25	40	45	10
SHRUB LAYER										
Acer glabrum	20	--	--	10	03	--	.5	--	--	--
Alnus crispa	25	40	30	07	40	50	30	35	15	35
Menziesia glabella	.5	--	01	--	01	05	30	.5	--	--
Ribes lacustre	.5	.5	.5	05	15	03	20	.5	--	.5
Salix scouleriana	.5	--	--	25	06	05	15	--	--	--
Shepherdia canadensis	.5	02	--	05	15	03	--	10	--	--
HERB-DWARF SHRUB LAYER										
Arnica cordifolia	05	01	35	01	10	18	15	--	15	.5
Aster conspicuus	10	.5	--	03	03	02	05	15	05	10
Calamagrostis rubescens	10	10	--	15	--	--	--	--	--	--
Cornus canadensis	03	.5	.5	01	08	05	08	05	--	02
Disporum trachycarpum	--	.5	--	--	--	01	--	01	--	--
Epilobium angustifolium	--	.5	--	.5	.5	01	02	.5	--	--
Fragaria virginiana	--	--	.5	.5	.5	--	--	.5	--	.5
Goodyera oblongifolia	--	.5	--	.5	.5	01	--	--	--	--
Linnaea borealis	05	10	--	--	.5	01	03	03	02	02
Lonicera involucrata	--	02	--	01	--	--	02	--	--	--
Lonicera utahensis	.5	01	--	01	01	03	08	.5	--	05
Picea glauca	--	--	--	01	01	01	--	--	--	--
Pyrola secunda	--	02	.5	.5	--	.5	.5	02	.5	.5
Rosa acicularis	01	05	--	--	03	--	--	01	.5	--
Rubus parviflorus	.5	02	--	10	04	08	01	.5	--	03
Smilacina racemosa	08	--	--	.5	01	01	--	--	--	--
Spiraea lucida	03	--	--	02	01	02	02	05	--	--
Stenanthium occidentale	--	--	.5	--	--	--	01	--	03	--
Vaccinium membranaceum	02	--	--	--	--	04	01	10	--	--
BRYOID LAYER										
Brachythecium spp.	.5	60	08	10	--	.5	--	.5	--	--
Dicranum fuscescens	.5	--	--	01	.5	.5	--	05	.5	--
Drepanocladus uncinatus	--	.5	.5	--	--	.5	--	--	--	.5
Hylocomium splendens	10	--	--	--	02	06	--	--	05	--
Pleurozium schreberi	25	05	--	30	06	03	06	50	55	40
Pohlia nutans	--	--	--	.5	.5	--	--	--	.5	.5
Ptilium crista-castrensis	15	--	--	.5	05	03	--	15	.5	--
Cladonia spp.	.5	.5	.5	--	--	--	--	.5	--	.5
Peltigera aphthosa	.5	02	02	01	02	03	05	.5	10	.05
Peltigera canina	--	.5	--	.5	--	--	--	.5	.5	.5
EPIPHYTES										
Alectoria sarmentosa ssp. sarmentosa	--	--	.5	.5	--	--	--	--	.5	.5
Bryoria fuscescens	.5	--	.5	.5	--	--	--	.5	.5	.5
Hypogymnia imshaugii	.5	--	.5	.5	--	--	--	.5	.5	--
Letharia vulpina	--	--	.5	--	--	--	--	.5	.5	.5
Parmeliopsis ambigua	.5	.5	.5	--	--	--	--	.5	.5	.5

Table 22. Stands of the lodgepole pine/feathermoss (C11) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	BB	HD	HD	HD	HD	MF	PA	SD
	10	20	20	20	20	20	10	20
	09	10	15	21	28	37	76	85
TREE LAYER								
Picea glauca	01	20	05	10	03	25	10	11
Pinus contorta	45	20	08	25	20	33	30	30
Pseudotsuga menziesii	--	--	--	05	07	15	.5	02
SHRUB LAYER								
Abies lasiocarpa	--	--	--	--	--	--	01	08
Menziesia glabella	--	--	--	.5	--	--	02	03
Picea glauca	.5	--	20	.5	.5	06	04	03
Shepherdia canadensis	--	--	--	--	.5	01	--	--
HERB-DWARF SHRUB LAYER								
Arnica cordifolia	--	--	--	--	.5	02	02	.5
Aster ciliolatus	--	--	--	--	.5	--	01	--
Aster conspicuus	15	--	--	--	.5	04	01	01
Cornus canadensis	05	06	05	02	.5	10	02	02
Elymus innovatus	10	--	--	01	--	--	.5	--
Fragaria virginiana	--	02	.5	--	.5	04	01	--
Goodyera oblongifolia	--	--	--	--	.5	--	.5	--
Linnaea borealis	03	--	.5	03	01	--	02	.5
Lonicera involucrata	01	--	--	.5	--	.5	.5	01
Mitella nuda	--	02	--	--	.5	02	--	--
Pyrola secunda	--	.5	.5	02	.5	.5	.5	01
Rosa acicularis	02	.5	--	01	01	10	01	01
Rubus pubescens	--	--	--	.5	--	10	--	--
Rubus strigosus	--	.5	--	--	--	02	.5	--
Spiraea lucida	.5	.5	--	04	--	03	02	.5
Vaccinium caespitosum	--	--	--	--	.5	01	--	--
Vaccinium scoparium	--	--	--	--	--	--	.5	01
Viburnum edule	.5	--	--	.5	.5	02	--	.5
BRYOID LAYER								
Dicranum scoparium	.5	.5	.5	.5	--	--	05	--
Hylocomium splendens	35	15	--	--	--	05	--	10
Pleurozium schreberi	40	35	75	80	40	70	30	40
Ptilium crista-castrensis	--	40	.5	05	--	15	--	15
Cladonia cenotea	.5	--	01	.5	--	--	--	--
Cladonia spp.	.5	.5	01	.5	--	--	--	.5
Peltigera aphthosa	10	--	03	05	50	.5	.5	.5
EPIPHYTES								
Alectoria sarmentosa ssp. sarmentosa	.5	--	--	--	--	--	--	.5
Hypogymnia physodes	.5	--	--	.5	--	--	--	.5
Letharia vulpina	.5	--	--	--	.5	--	--	--
Parmeliopsis ambigua	.5	--	--	--	--	--	--	.5

other *Pinus contorta* dominated v.t.s by its sparse shrub and herb-dwarf shrub layers and strongly developed bryoid layer dominated by feathermosses. Some stands with a mixed tree layer of *Pinus contorta* and *Picea* spp. intergrade with C13.

Other Studies: C11 is also described in BNP and JNP (Corns and Achuff 1982). Illingworth and Arlidge (1960) describe a similar *Pinus contorta/Cornus*-moss type from south central British Columbia. In BNP and JNP, Laidlaw (1971, *Picea mariana-Hylocomium*) has a similar type also.

C13: *Picea engelmannii-Abies lasiocarpa/Hylocomium splendens*

(Engelmann spruce-subalpine fir/feathermoss)

Environment: C13 occurs in central KNP on mesic Montane to Lower Subalpine (1100-2020 m) sites with moderate to steep slopes of various aspect. Soils are well drained Orthic Eutric Brunisols on morainal and colluvial landforms.

Table 23. Stands of the Engelmann spruce-subalpine fir/feathermoss (C13) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	BB	BB	BB	HD	HD	HD	HD	HD	PA	PA
	10	10	10	10	10	10	11	20	20	20
	07	21	24	08	27	42	13	16	12	29
TREE LAYER										
Abies lasiocarpa	15	25	10	08	--	20	10	--	--	10
Picea engelmannii	--	15	--	02	--	--	03	--	--	25
Picea glauca	--	--	15	--	08	01	--	20	15	--
Pinus contorta	--	--	--	02	--	03	--	03	10	--
SHRUB LAYER										
Abies lasiocarpa	--	15	10	03	--	01	05	--	--	--
Menziesia glabella	02	--	.5	--	--	--	03	--	--	--
Shepherdia canadensis	--	--	.5	--	01	--	--	02	03	--
HERB-DWARF SHRUB LAYER										
Abies lasiocarpa	.5	10	05	.5	--	01	.5	--	--	--
Arnica cordifolia	03	03	.5	.5	--	01	--	.5	--	--
Cornus canadensis	03	--	15	03	--	--	08	08	.5	--
Fragaria virginiana	--	--	--	02	.5	--	--	.5	.5	--
Goodyera oblongifolia	.5	--	--	.5	.5	--	.5	--	--	--
Linnaea borealis	.5	--	05	.5	05	02	--	03	03	--
Mitella nuda	.5	--	.5	--	--	--	--	.5	--	--
Pyrola secunda	01	01	.5	.5	02	.5	03	02	--	--
Rosa acicularis	--	--	02	.5	.5	--	--	--	.5	--
Rubus pedatus	--	--	01	--	--	--	30	--	--	--
Vaccinium membranaceum	.5	02	02	.5	--	--	04	--	--	--
Vaccinium scoparium	--	03	--	.5	--	.5	--	--	--	--
Symphoricarpos albus	--	--	--	--	.5	.5	--	--	--	--
Lycopodium annotinum	--	--	10	--	--	.5	01	--	--	--
BRYOID LAYER										
Dicranum fuscescens	01	--	.5	--	.5	--	--	--	--	--
Dicranum scoparium	--	--	--	.5	--	--	02	--	08	--
Hylocomium splendens	35	--	40	--	--	--	03	--	40	--
Pleurozium schreberi	35	--	40	25	--	05	70	75	40	--
Pohlia nutans	.5	.5	--	.5	--	--	.5	--	--	--
Ptilium crista-castrensis	05	--	05	.5	90	.5	01	05	--	--
Barbilophozia lycopodioides	--	--	.5	--	--	--	02	--	--	--
Ptilidium pulcherrimum	.5	--	--	--	--	.5	--	--	.5	--
Cladonia spp.	.5	03	.5	--	--	02	--	--	--	--
Peltigera aphthosa	01	05	05	03	--	10	.5	10	.5	--
EPIPHYTES										
Hypogymnia enteromorpha	.5	--	.5	--	--	.5	--	--	--	--
Letharia vulpina	.5	.5	--	--	--	--	.5	--	--	--

Vegetation: The closed tree layer (30-45%) is dominated by *Picea engelmannii* (10-35%) and *Abies lasiocarpa* (10-25%) often with *Pinus contorta* (2-10%) (Table 23). In the Montane, *Picea glauca* or hybrids of *Picea glauca* x *Picea engelmannii* are common. Shrub cover is low (1-10%) with *Abies lasiocarpa* (1-15%), *Menziesia glabella* (<1-3%) and *Shepherdia canadensis* (<1-3%) most common. The herb-dwarf shrub layer also has low cover (10-25%). Common species include: *Abies lasiocarpa* (1-10%), *Arnica cordifolia* (1-3%), *Cornus canadensis* (1-15%), *Fragaria virginiana* (1-2%), *Goodyera oblongifolia* (≤1%), *Linnaea borealis* (1-5%), *Pyrola secunda* (1-3%), *Rosa acicularis* (1-2%) and *Vaccinium membranaceum* (1-4%). The bryoid layer (45-90%) is dominated by *Pleurozium schreberi* (25-70%) with *Hylocomium splendens*, *Pohlia nutans*, *Ptilium crista-castrensis* and *Peltigera aphthosa* most common. *Hypogymnia enteromorpha* and *Letharia vulpina* are the most frequent epiphytes.

Stand ages are 150 to 400 years. C13 is successionally mature and regeneration of *Abies lasiocarpa* and *Picea engelmannii* is strong. C13 is distinguished primarily by high bryoid layer cover and low shrub and herb-dwarf shrub layer cover. Stands with a mixed tree layer of *Pinus contorta* and *Picea* spp. intergrade with C11. Those with *Pseudotsuga menziesii* may approach C5. Intergrades with C14 occur where there are moderate amounts of *Menziesia glabella* in the shrub layer and with C15 where *Vaccinium scoparium* cover approaches 15%.

Other Studies: C13 is also described in BNP and JNP (Corns and Achuff 1982). Similar forests are common from the Yukon and Northwest Territories to southern Alberta and British Columbia. In British Columbia, similar types are described by Kuchar (1978, spruce-fir/five-leaved bramble, spruce-fir/bryophytes-lichens) in Yoho National Park, and by Illingworth and Arlidge (1960, *Picea glauca-Abies lasiocarpa/Cornus*-moss).

In Alberta, Ogilvie (1976, *Picea-Abies/Hylocomium-Cornus*) has a similar type in BNP. In JNP, Hettinger (1975) has several similar types (*Picea glauca/Linnaea borealis/Hylocomium splendens*, *Picea glauca/Carex vaginata-Linnaea borealis*, *Picea glauca-Abies lasiocarpa/Arnica cordifolia*, and *Picea engelmannii-Abies lasiocarpa/Arnica diversifolia*). Elsewhere in Alberta, similar types are described by Corns (1978, *Picea glauca/Hylocomium splendens*) in the west central foothills, by Lesko and Lindsay (1973, white spruce-feathermoss-alpine fir), by Kirby and Ogilvie (1969, *Picea-Abies/Hylocomium-Cornus*), by Jacques and Legge (1974, spruce-fir/*Cornus canadensis-Hylocomium splendens*), and by Kondla (1978, spruce-fir/feathermoss and spruce/feathermoss). In southern Alberta, climax coniferous forest described by Cormack (1953) is comparable to C13 as is the spruce/fir/bunchberry type of Kuchar (1973) in Waterton Lakes National Park.

In the southern Yukon, Orloci and Stanek (1979, *Picea-Hylocomium-Peltigera* and *Picea-Cornus-Hylocomium*) have two similar types and Jeffrey (1964) in the Mackenzie Mountains of the southern Northwest Territories describes a similar mixed coniferous forest at high elevations.

C14: *Picea engelmannii-Abies lasiocarpa/Menziesia glabella/Vaccinium scoparium*

(Engelmann spruce-subalpine fir/false azalea)

Environment: C14 occurs commonly in central and northern KNP mostly in the Lower Subalpine (1500-1970 m) on mesic sites with moderate slopes and well to moderately well drained Eutric and Dystric Brunisols on morainal and colluvial landforms (Plate 48).

Vegetation: In the tree layer (20-45%), *Abies lasiocarpa* (5-25%) and *Picea engelmannii* (10-30%) are dominant (Table 24). *Menziesia glabella* (15-70%) dominates the shrub layer (25-80%) with *Rhododendron albiflorum* (5-10%), *Ribes lacustre* (0.5-3%) and *Abies lasiocarpa* (5-15%) often present also. The herb-dwarf shrub layer is well developed (15-50%) and commonly includes *Vaccinium membranaceum* (3-25%), *Vaccinium scoparium* (2-20%), *Abies lasiocarpa* (1-3%), *Arnica cordifolia* (1-10%), *Cornus canadensis* (1-10%), *Linnaea borealis* (1-5%), *Pyrola secunda* (1-3%) and *Lycopodium annotinum* (≤1%). The species-rich bryoid layer (45-90%) is dominated by *Pleurozium schreberi* (20-80%) along with *Dicranum scoparium* (5-10%), *Hylocomium splendens* (3-15%), *Ptilium crista-castrensis* (5-10%), *Barbilophozia lycopodioides* (5-40%) and *Peltigera aphthosa* (2-5%). Epiphytes are moderately abundant and include *Alectoria sarmentosa*, *Hypogymnia physodes*, *Letharia vulpina* and *Parmelia* spp.

Table 24. Stands of the Engelmann spruce-subalpine fir/false azalea (C14) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	BB	BB	HD	HD	HD	HD	HD	PA	PA	SD
	10	10	10	10	11	20	20	10	20	20
	22	25	07	11	29	34	89	71	45	06
TREE LAYER										
Abies lasiocarpa	20	10	10	.5	05	--	15	05	10	15
Picea engelmannii	15	--	--	08	02	03	05	18	20	05
Pinus contorta	--	05	02	.5	--	01	--	02	.5	--
TALL SHRUB LAYER										
Abies lasiocarpa	04	07	--	--	02	35	02	10	.5	02
Alnus crispa	--	--	05	05	--	--	--	--	--	--
Picea engelmannii	01	--	--	--	--	.5	--	.5	.5	--
SHRUB LAYER										
Abies lasiocarpa	10	05	01	--	02	05	--	10	05	05
Menziesia glabella	35	20	03	08	40	15	40	50	45	20
Rhododendron albiflorum	--	--	--	01	--	--	05	--	20	--
Ribes lacustre	--	--	--	--	--	--	--	--	.5	.5
HERB-DWARF SHRUB LAYER										
Arnica cordifolia	--	03	01	01	--	--	04	03	03	05
Cornus canadensis	--	05	05	01	--	.5	03	--	05	01
Linnaea borealis	--	03	--	03	--	.5	--	--	10	--
Pyrola secunda	.5	--	05	.5	--	--	--	.5	.5	--
Pyrola virens	.5	.5	--	01	--	--	--	--	--	--
Vaccinium membranaceum	08	--	--	10	01	01	03	15	--	--
Vaccinium scoparium	02	02	01	03	10	01	02	10	20	--
Lycopodium annotinum	--	.5	--	.5	--	--	--	--	.5	.5
BRYOID LAYER										
Dicranum fuscescens	03	--	03	--	25	--	--	05	--	--
Dicranum scoparium	--	--	--	--	10	.5	.5	--	--	--
Drepanocladus uncinatus	.5	--	--	.5	--	02	--	--	--	--
Hylocomium splendens	10	15	--	.5	--	05	.5	--	05	03
Pleurozium schreberi	10	20	45	.5	--	60	--	50	70	02
Ptilium crista-castrensis	--	20	05	07	--	.5	--	--	05	.5
Barbilophozia lycopodioides	10	--	--	.5	25	.5	--	25	--	--
Cladonia carneola	--	.5	--	.5	--	.5	--	--	--	.5
Peltigera aphthosa	05	--	.5	01	--	02	.5	--	05	--
Peltigera canina	05	--	.5	--	--	.5	--	--	--	--
EPIPHYTES										
Alectoria sarmentosa ssp. sarmentosa	.5	--	--	.5	--	--	--	.5	.5	.5
Bryoria fuscescens	.5	--	--	--	--	--	--	.5	.5	.5
Letharia vulpina	.5	--	.5	.5	.5	--	.5	--	.5	--
Parmeliopsis ambigua	.5	.5	--	.5	--	--	--	--	.5	.5
Parmeliopsis hyperopta	.5	.5	--	--	--	--	--	--	--	.5

C14 is successionally mature with stand ages of 175 to 400 years. *Abies lasiocarpa* regeneration is exceptionally strong. The dominance of *Menziesia glabella* in the shrub layer differentiates C14 from most other v.t.s. Stands with both *Pinus contorta* and *Picea engelmannii* in the tree layer may intergrade with C20. Stands with low *Menziesia glabella* cover intergrade with C13 and those with moderate *Rhododendron albiflorum* cover, with C21.

Other Studies: C14 is also described in BNP and JNP (Corns and Achuff 1982) and in MRNP and GNP (Achuff and Dudynsky 1984). In British Columbia, McLean (1970) describes an *Abies* *lasiocarpa -Menziesia ferruginea* type, Kujala (1945) has a *Picea engelmannii-Abies lasiocarpa/ Menziesia-Vaccinium membranaceum/Tiarella trifoliata-Rubus pubescens-Rhododendron albiflorum* type and Lea (1984) has an alpine fir-smooth Pacific menziesia-grouseberry-heart-leaved arnica type. In JNP, similar types are described by Hettinger (1975, *Picea engelmannii-Abies lasiocarpa/Menziesia glabella-Vaccinium membranaceum*), La Roi (1975, *Picea engelmannii-Abies lasiocarpa/Menziesia glabella/Valeriana sitchensis/Vaccinium scoparium/Pleurozium schreberi*), and Beil (1966). In BNP, Trottier and Scotter (1973) recognize similar types (*Picea-Abies/Menziesia glabella-Vaccinium scoparium, Picea-Abies/Menziesia glabella*/moss). Similar types also are described in Alberta by Corns (1978 and 1983, *Picea engelmannii-Abies lasiocarpa/Menziesia glabella*) in west central Alberta and in the northern foothills, by Kondla (1978, spruce-fir/false azalea-feathermoss) in Kananaskis Provincial Park, and by Ogilvie (1976, Kirby and Ogilvie 1969, *Picea-Abies/Menziesia glabella-Lycopodium annotinum*). In other parts of Alberta, similar types are noted by Jacques and Legge (1974) in the Kananaskis area (*Picea-Abies/Menziesia ferruginea-Tiarella trifoliata, Picea-Abies/Menziesia-Lycopodium annotinum*), Kuchar (1973) in Waterton Lakes National Park (fir/spruce/menziesia), and by Cormack (1953). Shepherd (1959) describes a *Picea engelmannii-Abies/Peltigera* association in BNP, JNP and Yoho National Park in Alberta and British Columbia. In Montana, Pfister *et al.* (1977) describe an *Abies lasiocarpa/Menziesia glabella* type. Daubenmire and Daubenmire (1968), in northern Idaho and eastern Washington, have a similar *Abies lasiocarpa/Menziesia ferruginea* type, as do Steele *et al.* (1983) in eastern Idaho and eastern Wyoming, and Steele *et al.* (1981) in central Idaho.

C15: *Picea engelmannii-Abies lasiocarpa/Vaccinium scoparium*

(Engelmann spruce-subalpine fir/grouseberry)

Environment: C15 occurs in central and southern KNP on mesic Upper Subalpine (1800-2300 m) sites with moderate to steep slopes and westerly and southerly aspects (Plate 58). Soils are well drained Eutric and Dystric Brunisols on colluvial and morainal landforms.

Vegetation: The tree layer (15-35%) is dominated by *Picea engelmannii* (5-30%) and *Abies lasiocarpa* (5-30%) and often contains some *Larix lyallii* (1-3%) (Table 25). *Abies lasiocarpa* (5-20%) dominates the shrub layer (5-25%). Other common species with low cover are *Picea engelmannii, Rhododendron albiflorum* and *Ribes lacustre*. Species diversity in the herb-dwarf shrub layer is high and total cover is 30 to 90%. *Vaccinium scoparium* (20-70%) is dominant, with *Arnica cordifolia* (5-15%), *Valeriana sitchensis* (1-5%), *Epilobium angustifolium* (<1-2%), *Erigeron peregrinus* (<1-5%), and *Fragaria virginiana* (1-5%) also important. The bryoid layer (15-80%) is heterogeneous and species cover values are low. Most common are *Pohlia nutans, Polytrichum juniperinum, Barbilophozia* spp., *Cladonia* spp. and *Peltigera* spp. Epiphytes are moderately abundant and *Letharia vulpina* is most common.

Stands are successionally mature and 145 to 400 years old. C15 is distinguished by the dominance of *Vaccinium scoparium* in the herb-dwarf shrub layer. C21 differs in having greater amounts of *Rhododendron albiflorum* and *Menziesia glabella*, and more *Vaccinium membranaceum* than *Vaccinium scoparium*. C14 has more *Menziesia glabella* and C20 has both more *Menziesia glabella* and *Pinus contorta* dominant in the tree layer.

Other Studies: C15 is also described in BNP and JNP (Corns and Achuff 1982). C15 and similar types occur from northern JNP, south along the Rocky Mountains to Arizona and New Mexico and west into British Columbia and eastern Washington. In British Columbia, similar types are described by Kuchar (1978) in Yoho National Park (spruce-fir/grouseberry), McLean (1970) for the south central part of the province (*Abies lasiocarpa-Vaccinium scoparium*) and Kujala (1945) in the central part (*Picea engelmannii-Abies lasiocarpa/Vaccinium scoparium*). In Alberta, La Roi (1975) in JNP (*Abies lasiocarpa/Vaccinium scoparium/Barbilophozia lycopodioides*) and Trottier and Scotter (1973) in BNP (*Picea-Abies/Vaccinium scoparium, Picea-Abies/Vaccinium scoparium-Phyllodoce* spp.-*Empetrum nigrum , Picea-Abies/- Phyllodoce* spp. have similar types. Kondla (1978, spruce-fir/grouseberry) has a similar type in Kananaskis Provincial Park. Further south, similar types are described by Pfister *et al.* (1977) in western Montana (*Abies lasiocarpa/Vaccinium scoparium*), by Bamberg and Major (1968) for the Flint Creek Mountains of west central Montana, by Patten (1963) for the Madison Range of southwestern Montana, and Daubenmire and Daubenmire (1968) for northern Idaho and eastern Washington. In Wyoming, similar types are described by Romme (1982) in Yellowstone National Park, Hoffman and Alexander (1976) for the Bighorn Mountains (*Picea engelmannii/*

Table 25. Stands of the Engelmann spruce-subalpine fir/grouseberry (C15) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	BB	HD	HD	HD	JD	JD	PA	PA	SD	SD
	10	10	20	20	10	10	10	20	20	20
	28	32	57	83	36	37	72	43	75	82
TREE LAYER										
Abies lasiocarpa	15	03	16	08	10	30	05	18	20	20
Larix lyallii	07	01	--	--	--	--	--	03	--	--
Picea engelmannii	10	04	01	10	05	03	25	10	20	05
Pinus albicaulis	--	--	03	--	01	02	--	--	--	--
TALL SHRUB LAYER										
Abies lasiocarpa	08	--	03	.5	03	.5	05	05	15	05
Picea engelmannii	02	.5	--	--	01	--	.5	--	05	--
SHRUB LAYER										
Abies lasiocarpa	10	--	03	05	03	20	10	.5	20	10
Picea engelmannii	--	06	--	--	--	--	05	.5	--	--
Rhododendron albiflorum	--	--	08	.5	--	--	--	--	--	--
Ribes lacustre	--	--	01	--	.5	.5	--	--	--	--
HERB-DWARF SHRUB LAYER										
Abies lasiocarpa	--	.5	02	--	--	--	.5	02	.5	--
Achillea millefolium	01	--	--	--	.5	.5	--	--	.5	.5
Anemone occidentalis	--	03	--	--	--	--	--	02	.5	--
Antennaria lanata	02	.5	--	--	01	--	--	--	--	--
Antennaria racemosa	.5	--	--	--	01	.5	--	--	.5	.5
Arnica cordifolia	--	.5	05	06	10	20	15	--	01	02
Epilobium angustifolium	--	.5	.5	.5	5	.5	--	.5	.5	02
Erigeron peregrinus	01	--	--	--	01	.5	--	05	.5	--
Erythronium grandiflorum	10	05	--	--	--	05	--	--	--	--
Fragaria virginiana	03	01	01	.5	05	05	01	03	.5	03
Pedicularis bracteosa	01	--	--	01	--	--	02	01	--	--
Potentilla diversifolia	.5	--	.5	--	01	--	--	--	--	--
Stenanthium occidentale	--	--	.5	--	--	.5	--	--	.5	.5
Thalictrum occidentale	--	--	--	--	.5	--	--	.5	05	--
Vaccinium scoparium	40	70	10	25	45	10	35	40	05	05
Valeriana sitchensis	05	05	--	.5	08	01	03	05	.5	--
BRYOID LAYER										
Pleurozium schreberi	--	--	--	--	--	--	45	--	02	01
Pohlia nutans	--	--	.5	05	--	--	--	05	--	--
Polytrichum juniperinum	.5	--	--	05	05	--	--	30	05	--
Barbilophozia lycopodioides	--	--	--	50	--	--	--	--	10	--
Peltigera aphthosa	01	--	.5	.5	--	--	05	--	.5	.5
Peltigera canina	--	--	.5	03	--	01	--	.5	.5	.5
Peltigera rufescens	.5	03	--	02	.5	--	--	.5	--	--
EPIPHYTES										
Alectoria sarmentosa ssp. sarmentosa	--	--	--	.5	.5	--	--	--	.5	--
Letharia vulpina	--	--	.5	.5	--	.5	--	.5	.5	.5

Vaccinium scoparium, *Abies lasiocarpa/Vaccinium scoparium*), Reed (1976, *Picea engelmannii-Vaccinium scoparium*) in the Wind River Mountains, Despain (1973, *Picea engelmannii-Abies lasiocarpa*) in the Bighorn Mountains, Wirsing and Alexander (1975) for southeast Wyoming (*Abies lasiocarpa/Vaccinium scoparium*), Oosting and Reed (1952) in the Medicine Bow Mountains, and Steele *et al.* (1983) in the Bighorn Mountains, the Wind River Range and the Uinta Mountains in Utah. Pfister (1972) describes an *Abies lasiocarpa/Vaccinium scoparium* type from Utah. In Colorado, similar types are noted by Hess (1981) and by Hoffman and Alexander (1980). Moir and Ludwig (1979) describe a similar type in Arizona and New Mexico.

C16: *Populus tremuloides/Elymus innovatus-Lathyrus ochroleucus*

(aspen/hairy wild rye-peavine)

Environment: C16 occurs on mesic Montane sites in central KNP. Its distribution is not extensive and only one stand, near Daer Tower at 1560 m, was sampled. C16 generally occurs on gentle to moderate slopes of southerly or westerly aspect. Soils are usually well drained Orthic Eutric Brunisols on fluvial or morainal landforms.

Vegetation: *Populus tremuloides* (30%) is dominant in the tree layer (Table 26). The shrub layer is moderate (10-20%) with *Shepherdia canadensis* (5-15%), *Rosa acicularis* (5-10%) and *Juniperus communis* (1%) most common. Total herb-dwarf shrub layer cover is 40 to 85% with *Calamagrostis rubescens* (15-25%) usually dominant in KNP. In BNP and JNP, *Elymus innovatus* is often dominant. Other important species are *Lathyrus ochroleucus* (1-3%), *Fragaria virginiana* (1-5%), *Arctostaphylos uva-ursi* (5-15%), *Aster conspicuus* (1-7%), *Spiraea lucida* (3%) and *Linnaea borealis* (2-5%). Lichens and bryophytes are rare.

C16 is successionally intermediate to mature with stands 60 to 120 years old, based on data from BNP and JNP. *Populus tremuloides* regeneration is often present indicating a stable, mature stage. But in some stands small amounts of *Picea glauca* or *Pseudotsuga menziesii* suggest a future increase in these latter species, perhaps with succession to C44.

Both C16 and C22 are dominated by *Populus tremuloides*. C16 differs from C22 by occurring on gentle slopes of fluvial and morainal landforms rather than the steeper, colluvial landforms of C22. C16 typically has higher cover of *Lathyrus ochroleucus* and *Galium boreale*, while *Arctostaphylos uva-ursi* cover is usually greater in C22. C44 differs from C16 in having a mixed coniferous-deciduous tree layer, although some patches within C44 stands may be dominated by *Populus tremuloides*.

Other Studies: C16 is also described in BNP and JNP (Corns and Achuff 1982). In British Columbia, Kuchar (1978) describes a similar aspen-balsam poplar forest in Yoho National Park, Beil (1974) has a *Populus tremuloides/Rosa acicularis* type, and Tisdale and McLean (1957) a *Populus tremuloides/Calamagrostis* type. In Alberta, similar types are described by Corns (1978, *Populus tremuloides/Viburnum edule/Rubus pubescens*) in the northern foothills, Mackenzie-Grieve (1970) for the Red Deer River area east of BNP, Moss (1955, aspen consociation of the *Populus* association), Kondla (1978) in Kananaskis Provincial Park (aspen/hairy wild rye-bearberry), Jeffrey *et al.* (1968) in the southern Rocky Mountains, Ogilvie (1961) for the Porcupine Hills (aspen type), Ogilvie (1963, *Populus tremuloides* type), and Kuchar (1973) in Waterton Lakes National Park (poplar forest). In the Cypress Hills of Alberta and Saskatchewan, Newsome and Dix (1968) describe *Populus tremuloides* dominated forests which are similar to C16. Related v.t.s in central Saskatchewan are described by Kabzems *et al.* (1976, *Populus/Aralia/Linnaea*) and Swan and Dix (1966, Dix and Swan 1971) (poplar forest).

At the northern extreme, Douglas (1974) records a *Populus tremuloides/Arctostaphylos uva-ursi* type in the southwestern Yukon. Further south, *Elymus innovatus* is replaced by *Elymus glaucus* and in western Colorado, *Carex geyeri* becomes dominant (Hoffman and Alexander 1980, *Populus tremuloides/Carex geyeri*). Hess (1981) also describes a similar type from northern Colorado.

C18: *Pinus contorta/Shepherdia canadensis/Vaccinium scoparium*

(lodgepole pine/buffaloberry/grouseberry)

Environment: C18 occurs on mesic Lower Subalpine sites (1780-1840 m) on moderate to steep slopes and westerly aspects. C18 is not common in KNP and only two stands were sampled, one on Whitetail Creek and another near Marble Canyon. The soils are well drained Eutric Brunisols on morainal and colluvial landforms.

Table 26. Stands of the aspen/hairy wild rye-peavine (C16) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	AW 60 32	KS 50 43	KS 50 80	KS 51 67	PA 70 15	PA 71 75	HD 10 01
TREE LAYER							
Populus tremuloides	31	85	60	45	25	55	30
TALL SHRUB LAYER							
Picea glauca	01	02	--	08	.5	--	--
Populus tremuloides	--	--	--	--	01	--	--
SHRUB LAYER							
Juniperus communis	--	--	.5	.5	.5	--	01
Picea glauca	05	08	08	--	--	.5	--
Populus tremuloides	02	.5	.5	.5	--	.5	--
Rosa acicularis	04	20	02	10	.5	.5	07
Shepherdia canadensis	01	15	01	15	20	05	07
Symphoricarpos albus	--	03	.5	10	--	--	--
HERB-DWARF SHRUB LAYER							
Achillea millefolium	01	01	.5	.5	--	.5	--
Anemone multifida	03	--	.5	.5	--	--	--
Arctostaphylos uva-ursi	25	--	.5	15	02	.5	05
Aster ciliolatus	.5	02	02	.5	--	--	--
Aster conspicuus	.5	25	03	02	03	02	07
Bromus ciliatus	--	--	10	05	--	--	--
Calamagrostis rubescens	--	--	--	--	15	60	25
Castilleja miniata	--	.5	.5	--	.5	--	01
Elymus innovatus	45	15	40	18	--	01	--
Epilobium angustifolium	--	.5	--	--	--	03	01
Festuca scabrella	--	.5	--	12	--	--	--
Fragaria virginiana	02	03	05	01	--	05	--
Galium boreale	01	03	.5	08	--	02	--
Hedysarum sulphurescens	--	--	--	03	--	05	01
Lathyrus ochroleucus	02	08	08	02	03	01	-
Pyrola secunda	.5	.5	--	.5	--	02	-
Senecio indecorus	06	03	01	.5	--	.5	--
Spiraea lucida	--	--	--	--	.5	--	03
Vicia americana	01	03	12	--	.5	.5	--
BRYOID LAYER							
Drepanocladus uncinatus	--	--	--	.5	.5	--	.5
Hylocomium splendens	--	--	--	.5	--	.5	--
Pohlia nutans	--	--	--	.5	--	--	.5
Pylaisiella polyantha	--	--	--	--	.5	--	.5
Thuidium abietinum	02	--	--	.5	--	--	--
EPIPHYTES							
Peltigera aphthosa	--	--	--	.5	.5	--	--
Peltigera canina	--	--	--	.5	--	--	.5

Vegetation: The tree layer is closed (20-55%) and dominated by *Pinus contorta* (20-45%) with *Picea engelmannii* (1-5%) often present (Table 27). *Shepherdia canadensis* (10-30%) dominates the shrub layer (20-35%) and *Juniperus communis* (1-5%) is common. Total cover of the herb-dwarf shrub layer is 35 to 85% and *Vaccinium scoparium* (20-45%) is dominant. Other common species are *Vaccinium membranaceum* (5%), *Epilobium angustifolium* (2-5%), *Aster conspicuus* (1-5%), *Arnica*

Table 27. Stands of the lodgepole pine/buffaloberry/grouseberry (C18) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	HD	MF	AW	JD	PA
	21	20	70	70	81
	13	78	67	87	21
TREE LAYER					
Abies lasiocarpa	--	05	--	--	--
Picea engelmannii	01	--	--	.5	05
Pinus contorta	20	21	40	25	45
SHRUB LAYER					
Juniperus communis	--	02	02	01	03
Menziesia glabella	10	--	01	--	--
Pinus contorta	--	--	.5	15	.5
Shepherdia canadensis	25	02	12	15	25
HERB-DWARF SHRUB LAYER					
Arctostaphylos uva-ursi	--	.5	02	35	--
Arnica cordifolia	10	--	03	.5	10
Aster conspicuus	10	10	01	--	--
Elymus innovatus	.5	20	06	50	01
Epilobium angustifolium	05	02	09	--	02
Fragaria virginiana	.5	01	04	--	--
Listera borealis	--	02	10	05	10
Pyrola secunda	.5	.5	.5	.5	--
Vaccinium membranaceum	05	05	--	--	--
Vaccinium scoparium	30	35	20	25	25
BRYOID LAYER					
Brachythecium spp.	30	--	01	--	--
Pleurozium schreberi	02	05	--	03	40
Cladonia spp.	.5	--	09	.5	.5
Peltigera aphthosa	02	--	--	.5	05

cordifolia (1-5%) and *Fragaria virginiana* (1-2%). Bryoid layer cover is 35 to 60% with *Pleurozium schreberi* (5-40%) dominant and *Cladonia* spp. (<1-5%) common. Epiphytes are scarce with *Letharia vulpina* most common.

Stand age ranges widely from 55 to 270 years and C18 is intermediate to advanced successionally. Succession to C13 seems likely. C18 is closely related to C6 and C19 and intergrading stands occur. C18 is distinguished from other v.t.s dominated by *Pinus contorta* and *Shepherdia canadensis* by the dominance of *Vaccinium scoparium* in the herb-dwarf shrub layer layer (Table 17).

Other Studies: C18 is also described in BNP and JNP (Corns and Achuff 1982). In British Columbia, the *Pinus contorta/Vaccinium scoparium* and *Pinus contorta/Calamagrostis-Vaccinium scoparium* types of Illingworth and Arlidge (1960) are similar and Lea (1984, lodgepole pine-soopolallie-grouseberry-pinegrass) also describes a similar type. Similar types are described in Alberta by Kondla (1978, pine/grouseberry, pine/grouseberry-wild rye) in Kananaskis Provincical Park and by Cormack (1953).

Pfister *et al.* (1977) in western Montana describe similar *Pinus contorta* dominated seral stages of the *Picea/Linnaea borealis* type where *Shepherdia canadensis* and *Vaccinium scoparium* are abundant. In northern Wyoming, *Pinus contorta* dominated seral stands of the *Picea engelmannii/Vaccinium scoparium*, *Abies lasiocarpa/Vaccinium scoparium*, and *Abies lasiocarpa/Shepherdia canadensis* types (Hoffman and Alexander 1976) are similar to C18. In southern Wyoming, Wirsing and Alexander (1975) describe a *Pinus contorta/Vaccinium scoparium* type and Steele *et al.* (1983) in western Wyoming also have a *Pinus contorta/Vaccinium scoparium* type.

C19: *Pinus contorta/Shepherdia canadensis/Linnaea borealis*

(lodgepole pine/buffaloberry/twinflower)

Environment: C19 occurs on mesic Montane to Lower Subalpine sites (1230-1830 m) on moderate slopes with southerly and westerly aspects throughout KNP. The soils are well drained Eutric Brunisols on morainal, colluvial, and fluvial landforms.

Vegetation: *Pinus contorta* (20-40%) dominates the closed tree layer (Table 28). *Picea glauca* occurs with low cover in many stands. The shrub layer (10-40%) is dominated by *Shepherdia canadensis* (10-40%). *Juniperus scopulorum* (<2%) and *Rosa acicularis* (1-2%) are also frequently present. The herb-dwarf shrub layer (15-65%) is dominated by *Linnaea borealis* (10-40%). *Aster conspicuus* (1-10%), *Arnica cordifolia* (1%) and *Cornus canadensis* (1-3%) are often present. *Arctostaphylos uva-ursi*, *Fragaria virginiana*, *Lonicera involucrata*, *Epilobium angustifolium* and *Pyrola secunda* occur with low cover but high frequency. The bryoid layer has total cover of 10 to 50% and is dominated by *Pleurozium schreberi* (10-45%) with lesser amounts of *Hylocomium splendens* (<1-10%) and *Peltigera aphthosa* (1-5%). Epiphytes are scarce with *Hypogymnia physodes*, *Letharia vulpina* and *Bryoria* spp. most common.

Stand age is 55 to 125 years and C19 is intermediate to advanced successionally. Most stands are of fire origin and further succession to *Picea* dominated forest seems likely.

C19 is closely related to C3, C6, C9, C18, C38 and C39 and intergrading stands occur. C19 differs (Table 17) primarily in having the herb-dwarf shrub layer dominated by *Linnaea borealis* rather than by *Arctostaphylos uva-ursi* (C3), *Aster conspicuus* (C6), *Vaccinium caespitosum* (C9), *Vaccinium scoparium* (C18), *Calamagrostis rubescens* (C38) or *Cornus canadensis* (C39).

Other Studies: C19 is also described in BNP and JNP (Corns and Achuff 1982). In British Columbia, Kuchar (1978) describes several similar types (lodgepole pine/buffaloberry/twinflower-bunchberry, lodgepole pine-spruce/buffaloberry/twinflower-bunchberry) in Yoho National Park and Lea (1984, lodgepole pine-soopolallie-pinegrass-northern twinflower) has a similar type in the East Kootenays. In Alberta, similar types are described by Hettinger (1975, seral stage of *Pseudotsuga menziesii/Elymus* and La Roi (1975) both in JNP. In west central Alberta, Corns (1983) notes a *Pinus contorta/Viburnum edule/Rubus pubescens* type and a *Pinus contorta/Spiraea lucida/Cornus canadensis* type which are perhaps similar to C19. In the Kananaskis area, Kondla (1978) describes similar types: pine/twinflower, pine/buffaloberry-twinflower, and pine/buffaloberry-feathermoss. Cormack (1953) in the southern Alberta foothills notes a similar vegetation as seral to spruce-fir climax. In western Montana (Pfister *et al.* 1977), the seral stage of the *Picea/Linnaea borealis* type is very similar. Furthest south is a *Pinus contorta/Shepherdia canadensis* type from Wyoming (Steele *et al.* 1983).

C20: *Pinus contorta/Menziesia glabella/Vaccinium scoparium*

(lodgepole pine/false azalea/grouseberry)

Environment: C20 occurs on mesic, mostly Lower Subalpine sites (1350-1970 m) throughout KNP on gentle to moderate slopes of various aspect. The soils are well drained Eutric Brunisols developed on morainal, colluvial, and fluvial landforms.

Vegetation: *Pinus contorta* (10-50%) dominates the closed tree layer (20-50%) with *Picea* spp. (5-10%) and *Abies lasiocarpa* (3-10%) often also present (Table 29). The shrub layer is well developed (20-90%) with *Menziesia glabella* (20-55%) dominant. Other common species include *Abies lasiocarpa* (3-10%), *Rhododendron albiflorum* (1-10%) and *Picea* spp. (>1%). *Vaccinium scoparium* (15-40%) dominates the herb-dwarf shrub layer (20-75%) with *Arnica cordifolia* (1-5%), *Cornus canadensis* (2-4%) and *Linnaea borealis* (1-3%) common. *Epilobium angustifolium*, *Pyrola secunda* and *Vaccinium membranaceum* occur frequently but with low cover. The bryoid layer is generally well developed (25-65%) with *Pleurozium schreberi* (10-40%), *Hylocomium splendens* (5-15%) and *Peltigera aphthosa* (1-2%) most important. *Pohlia nutans*, *Ptilium crista-castrensis*, *Cladonia ecmocyna*, *Drepanocladus uncinatus*, *Barbilophozia lycopodioides* and *Dicranum fuscescens* occur often with low cover. Epiphytes are moderate to sparse with *Letharia vulpina*, *Hypogymnia physodes* and *Bryoria* spp. most common.

Table 28. Stands of the lodgepole pine/buffaloberry/twinflower (C19) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	BB	BB	HD	HD	MF	MF	PA	SD
	10	10	20	20	20	20	10	20
	10	12	05	27	25	63	77	18
	TREE LAYER							
Picea glauca	--	05	--	02	--	--	05	--
Pinus contorta	40	20	21	33	43	40	35	40
Pseudotsuga menziesii	--	--	09	05	02	--	--	--
	SHRUB LAYER							
Juniperus communis	01	.5	.5	--	01	02	--	07
Juniperus scopulorum	--	--	05	--	--	--	--	--
Shepherdia canadensis	10	15	40	.5	10	45	35	07
Viburnum edule	--	02	--	.5	--	--	--	.5
	HERB-DWARF SHRUB LAYER							
Arctostaphylos uva-ursi	01	.5	--	--	08	09	.5	.5
Arnica cordifolia	--	01	.5	--	01	01	--	--
Aster conspicuus	15	10	.5	.5	03	11	03	01
Calamagrostis rubescens	--	.5	--	--	01	--	15	--
Chimaphila umbellata	--	.5	.5	--	--	--	.5	--
Cornus canadensis	01	03	--	.5	--	--	10	.5
Epilobium angustifolium	--	.5	--	.5	--	01	--	.5
Fragaria virginiana	--	10	.5	.5	.5	03	05	.5
Galium boreale	--	.5	--	.5	--	--	.5	--
Linnaea borealis	40	15	10	05	40	13	25	03
Lonicera involucrata	--	02	--	--	.5	.5	--	.5
Lonicera utahensis	--	--	05	--	.5	.5	--	--
Pyrola secunda	--	--	05	.5	--	01	.5	--
Pyrola virens	.5	.5	--	--	--	01	--	--
Rosa acicularis	03	10	.5	01	01	02	01	.5
Spiraea lucida	--	.5	04	02	--	03	.5	.5
Zygadenus elegans	05	--	--	--	01	.5	--	--
Thalictrum sp.	--	01	.5	--	01	--	--	--
	BRYOID LAYER							
Dicranum fuscescens	--	.5	03	03	--	--	--	--
Dicranum polysetum	.5	--	--	--	--	--	05	--
Drepanocladus uncinatus	03	--	--	--	--	--	.5	.5
Eurhynchium pulchellum	.5	--	20	--	.5	.5	--	.5
Hylocomium splendens	09	.5	20	--	--	--	.5	01
Pleurozium schreberi	13	45	--	10	--	02	60	01
Polytrichum juniperinum	--	--	.5	--	--	--	.5	--
Cladonia ecmocyna	01	.5	.5	05	--	--	--	.5
Cladonia spp.	--	03	--	04	.5	--	.5	.5
Peltigera aphthosa	--	02	05	.5	--	--	10	.5
	EPIPHYTES							
Bryoria spp.	.5	.5	.5	.5	--	--	.5	--
Alectoria sarmentosa ssp. sarmentosa	.5	--	--	--	--	--	--	.5
Cetraria pinastri	--	.5	--	--	--	--	.5	--
Hypogymnia imshaugii	.5	--	.5	--	--	--	--	--
Hypogymnia physodes	--	--	.5	--	--	--	.5	.5
Letharia vulpina	.5	--	.5	--	--	--	--	.5
Parmeliopsis ambigua	.5	--	.5	--	--	--	--	--

Table 29. Stands of the lodgepole pine/false azalea/grouseberry (C20) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	BB	HD	HD	HD	MF	MF	SD	SD	SD	SD
	10	20	20	20	20	20	20	20	20	21
	34	33	67	74	69	76	17	22	32	43
					TREE LAYER					
Abies lasiocarpa	04	--	--	04	13	02	--	10	05	03
Picea spp.	--	--	06	05	07	.5	20	10	10	17
Pinus contorta	35	15	11	10	50	55	35	20	20	20
					SHRUB LAYER					
Abies lasiocarpa	05	01	--	--	--	--	15	35	03	17
Alnus crispa	--	--	--	02	13	15	--	--	--	--
Menziesia glabella	65	05	55	55	15	12	10	30	30	20
Picea spp.	--	05	.5	--	--	--	10	--	.5	--
Rhododendron albiflorum	25	01	35	07	--	05	.5	--	10	--
Shepherdia canadensis	--	--	--	--	11	--	07	05	--	15
					HERB-DWARF SHRUB LAYER					
Abies lasiocarpa	.5	.5	--	03	--	--	.5	--	--	.5
Arnica cordifolia	10	--	--	05	13	01	03	--	02	.5
Aster conspicuus	--	--	--	01	04	03	10	--	--	05
Chimaphila umbellata	--	.5	--	--	--	--	.5	--	--	.5
Clintonia uniflora	--	--	--	.5	02	--	--	02	--	03
Cornus canadensis	--	--	--	--	--	04	02	03	--	03
Epilobium angustifolium	.5	--	--	.5	.5	--	.5	.5	.5	.5
Fragaria virginiana	--	01	--	.5	01	--	--	--	--	.5
Ledum groenlandicum	--	--	--	--	--	03	--	08	--	03
Linnaea borealis	--	--	--	.5	02	01	03	01	--	02
Lonicera involucrata	--	--	--	.5	03	02	--	02	--	.5
Pyrola secunda	--	01	--	--	.5	01	--	--	.5	.5
Spiraea lucida	--	--	--	--	.5	--	.5	.5	--	--
Vaccinium membranaceum	--	--	02	35	12	15	03	.5	02	--
Vaccinium scoparium	.5	60	01	25	15	05	--	05	--	02
					BRYOID LAYER					
Dicranum fuscescens	10	--	25	--	--	.5	--	.5	--	.5
Drepanocladus uncinatus	.5	--	.5	--	--	--	.5	--	--	.5
Hylocomium splendens	--	--	05	--	--	15	--	05	03	10
Pleurozium schreberi	01	.5	35	--	20	60	25	20	05	10
Pohlia nutans	.5	--	.5	30	--	--	--	--	.5	.5
Polytrichum juniperinum	.5	--	--	--	02	--	--	.5	--	--
Ptilium crista-castrensis	--	--	--	--	03	05	10	10	--	.5
Barbilophozia lycopodioides	--	--	.5	--	--	--	--	.5	.5	.5
Cladonia ecmocyna	05	--	.5	30	--	--	02	--	.5	--
Peltigera aphthosa	10	--	01	--	--	.5	01	.5	--	--
					EPIPHYTES					
Bryoria spp.	.5	--	.5	.5	.5	.5	.5	--	.5	.5
Cetraria pinastri	.5	--	--	--	--	--	--	.5	.5	--
Hypogymnia physodes	--	--	.5	--	.5	.5	--	--	--	.5
Letharia vulpina	.5	--	.5	.5	--	.5	--	--	.5	.5

C20 is intermediate successionally with stand ages of 60 to 190 years. Succession to C14 appears most likely. C20 differs from C18 by having *Menziesia glabella* the dominant shrub rather than *Shepherdia canadensis*, although both v.t.s have *Vaccinium scoparium* dominant in the herb-dwarf shrub layer. C14 differs in that *Picea engelmannii* is the dominant tree rather than *Pinus contorta*.

Other Studies: C20 is also described in BNP and JNP (Corns and Achuff 1982). In British Columbia, Kuchar (1978) describes a lodgepole pine-spruce/menziesia/grouseberry type from Yoho National Park, Kujala (1945) has a similar type in northeastern British Columbia and Lea (1984, lodgepole pine-smooth Pacific menziesia-grouseberry-moss) describes a similar type in the East Kootenays. In JNP, La Roi (1975) describes a similar *Pinus contorta/Abies lasiocarpa/Menziesia glabella/Vaccinium scoparium/Pleurozium schreberi* type and in BNP, Trottier and Scotter (1973) have a *Pinus contorta/Vaccinium scoparium* type. In BNP and JNP, La Roi and Hnatiuk (1980) recognize a *Pinus contorta/Menziesia glabella/Vaccinium scoparium* type. Elsewhere in Alberta, Corns (1983) notes a comparable *Pinus contorta/Menziesia glabella/Rubus pubescens* type and a *Pinus contorta/Menziesia glabella/Rubus pedatus* type (Corns 1978), Ogilvie (1963) recognizes a *Pinus contorta/Menziesia glabella/Lycopodium annotinum* type, and Kondla (1978) in Kananaskis Provincial Park has a similar pine/false azalea type. The southernmost occurrence is in Wyoming (Steele *et al.* 1983).

C21: *Picea engelmannii-Abies lasiocarpa/Vaccinium membranaceum/Barbilophozia lycopodioides*

(Engelmann spruce-subalpine fir/tall bilberry/liverwort)

Environment: C21 occurs in the Lower to Upper Subalpine (1850-2200 m) of central and northern KNP on mesic, moderate to steep slopes of various aspect (Plate 62). Soils are well drained Eutric and Dystric Brunisols on colluvial and morainal landforms.

Vegetation: *Picea engelmannii* (5-25%) and *Abies lasiocarpa* (15-30%) are dominant in the tree layer (20-50%), with *Larix lyallii* (<1-5%) often present (Table 30). *Rhododendron albiflorum* (10-60%) characterizes the shrub layer (25-75%). *Abies lasiocarpa* (5-10%) and *Menziesia glabella* (2-10%) are also important shrubs. The herb-dwarf shrub layer (20-70%) is dominated by *Vaccinium membranaceum* (10-30%) and *Vaccinium scoparium* (5-35%). Also common are *Arnica cordifolia* (1-5%), *Phyllodoce empetriformis* (1-5%), *Valeriana sitchensis* (1-5%) and *Abies lasiocarpa* (<3%). The bryoid layer generally has high cover (40-90%) with *Barbilophozia lycopodioides* (10-60%), *Dicranum scoparium* (10-55%), *Pleurozium schreberi* (3-10%), *Peltigera aphthosa* (<1-5%) and *Cladonia ecmocyna* (<1-3%) most common. Epiphytes are moderately to scarcely abundant with *Letharia vulpina*, *Parmeliopsis* spp. and *Bryoria* spp. most frequent.

C21 is successionally mature with most stands 175 to >300 years old. C21 differs from C14 in having *Rhododendron albiflorum* and *Vaccinium membranaceum* dominant rather than *Menziesia glabella* and *Vaccinium scoparium*. Although C21 occurs mostly in the Upper Subalpine, whereas C14 is mostly in the Lower Subalpine, intergrading stands occur. C15 differs from C21 in having *Vaccinium scoparium* dominant in the herb-dwarf shrub layer and much less *Rhododendron albiflorum*, *Menziesia glabella* and *Vaccinium membranaceum*. Intermediates between C15 and C21 occur.

Other Studies: C21 is also described in BNP and JNP (Corns and Achuff 1982) and in MRNP and GNP (Achuff and Dudynsky 1984). In British Columbia, a similar spruce-fir/rhododendron type is described by Kuchar (1978) in Yoho National Park, by Clement (1981, alpine fir-white-flowered rhododendron-black blueberry-sitka valerian) in the Vernon area and by Lea (1984, Engelmann spruce-white-flowered rhododendron-Canadian bunchberry-moss) in the East Kootenays. In Alberta, similar types are described by Corns (1978) from the northern foothills (*Picea engelmannii-Abies lasiocarpa/Menziesia glabella*), Trottier and Scotter (1973) for BNP (*Picea-Abies/Rhododendron albiflorum-Vaccinium* spp., Baig (1972) for the Alberta Rockies (*Abies-Picea-Larix/Rhododendron*), and Beil (1966) for BNP and JNP.

In the western Cascades of Washington, *Picea engelmannii-Abies lasiocarpa/Vaccinium membranaceum* is noted by del Moral and Flemming (1979) and similar vegetation also occurs at Logan Pass in Glacier National Park, Montana as reported by Habeck (1969).

Table 30. Stands of the Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	HD	HD	HD	JD	JD	MF	MF	MF	PA	PA
	20	20	21	10	10	20	20	21	20	10
	78	88	18	08	21	58	90	00	25	70
TREE LAYER										
Abies lasiocarpa	03	13	03	04	--	30	08	25	10	15
Larix lyallii	07	.5	.5	01	--	--	--	--	--	.5
Picea engelmannii	.5	07	12	15	02	--	12	25	10	05
Pinus albicaulis	--	--	--	--	--	--	--	--	05	--
SHRUB LAYER										
Abies lasiocarpa	--	.5	.5	03	01	--	10	15	15	15
Menziesia glabella	--	05	05	05	02	17	45	--	15	--
Rhododendron albiflorum	--	48	65	73	78	07	35	43	20	30
HERB-DWARF SHRUB LAYER										
Abies lasiocarpa	--	.5	.5	--	.5	02	.5	04	--	.5
Arnica cordifolia	--	15	08	05	--	01	--	12	.5	05
Cassiope mertensiana	05	--	--	--	--	--	03	--	--	--
Listera cordata	--	.5	--	05	--	--	--	.5	--	--
Mitella nuda	--	.5	--	--	--	--	--	--	--	.5
Pedicularis bracteosa	--	.5	.5	01	--	--	--	.5	--	.5
Phyllodoce empetriformis	10	.5	.5	10	--	--	--	--	--	01
Pyrola secunda	--	--	.5	--	.5	.5	--	--	--	--
Senecio triangularis	--	.5	.5	--	--	--	--	.5	--	--
Stenanthium occidentale	--	.5	--	--	--	02	.5	02	--	--
Vaccinium membranaceum	25	03	65	--	30	13	32	05	15	25
Vaccinium scoparium	15	05	10	10	10	--	28	08	25	10
Valeriana sitchensis	--	--	--	05	--	--	--	12	--	.5
Veratrum eschscholtzii	--	.5	--	01	--	--	--	02	--	--
Viola orbiculata	--	01	--	.5	--	--	--	02	.5	--
BRYOID LAYER										
Brachythecium salebrosum	--	--	--	--	35	.5	05	--	--	--
Dicranum fuscescens	--	.5	--	03	--	--	.5	--	--	--
Dicranum scoparium	05	05	--	--	10	--	01	.5	10	05
Drepanocladus uncinatus	--	.5	--	--	--	--	--	18	.5	--
Pleurozium schreberi	--	.5	03	--	05	04	10	--	--	--
Barbilophozia hatcheri	--	--	--	--	--	--	30	--	--	--
Barbilophozia lycopodioides	.5	80	--	35	10	--	30	.5	30	60
Lophozia ventricosa var. ventricosa	--	.5	--	.5	--	--	--	--	--	--
Lophozia obtusa	--	02	--	--	--	--	--	17	--	--
Cladonia carneola	02	--	--	01	--	--	--	--	.5	--
Cladonia ecmocyna	02	--	--	--	--	.5	02	--	.5	--
Peltigera aphthosa	01	.5	.5	01	.5	01	02	.5	05	--
EPIPHYTES										
Bryoria fremontii	--	--	--	.5	.5	--	--	--	--	--
Alectoria sarmentosa ssp. sarmentosa	--	--	--	--	.5	--	--	--	--	.5
Hypogymnia physodes	--	--	--	--	--	--	.5	.5	--	--
Letharia vulpina	.5	--	--	.5	.5	.5	.5	--	.5	--
Usnea sp.	--	.5	--	--	--	--	--	.5	--	--
Bryoria spp.	--	--	--	--	--	.5	.5	.5	--	.5

C22: *Populus tremuloides/Elymus innovatus-Aster conspicuus*

(aspen/hairy wild rye-showy aster)

Environment: C22 occurs on mesic to subxeric, Montane and Lower Subalpine sites on westerly and southerly aspects and steep slopes. Soils are rapidly to well drained Orthic Regosols and Eutric Brunisols on colluvial landforms. C22 in KNP occurs on the Mitchell Range and on Mount Wardle.

Vegetation: The closed canopy (Table 31) is dominated by *Populus tremuloides* (15-40%).

Table 31. Stands of the aspen/hairy wild rye-showy aster (C22) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	IC	JD	JD	JD	JE	JE	JE	MF
	60	70	81	81	80	81	81	20
	22	64	26	27	18	13	34	62
TREE LAYER								
Populus tremuloides	40	10	65	40	15	20	25	22
SHRUB LAYER								
Juniperus communis	--	10	01	01	.5	02	01	12
Populus tremuloides	--	40	05	25	12	02	20	05
Rosa acicularis	03	01	25	05	10	03	05	02
Shepherdia canadensis	02	.5	02	01	--	--	.5	40
HERB-DWARF SHRUB LAYER								
Achillea millefolium	--	01	.5	.5	01	.5	.5	01
Allium cernuum	--	--	--	--	.5	--	.5	.5
Anemone multifida	--	.5	--	.5	--	.5	--	.5
Arctostaphylos uva-ursi	--	35	30	40	05	08	12	20
Artemisia michauxiana	--	--	--	--	01	.5	--	--
Aster conspicuus	30	10	01	10	--	--	--	10
Campanula rotundifolia	--	.5	.5	.5	.5	.5	.5	.5
Castilleja miniata	--	.5	01	--	--	--	--	--
Elymus innovatus	50	30	10	40	20	07	23	.5
Epilobium angustifolium	30	.5	--	--	--	--	--	01
Fragaria virginiana	03	02	--	.5	--	.5	--	03
Gentiana amarella	--	--	--	.5	--	--	--	.5
Hedysarum sulphurescens	--	01	05	10	08	--	08	03
Juniperus horizontalis	--	--	--	01	--	15	--	--
Koeleria cristata	--	--	.5	01	--	--	01	--
Oxytropis splendens	--	.5	.5	.5	--	--	--	--
Penstemon procerus	--	--	--	.5	01	.5	.5	--
Poa spp.	--	--	10	10	.5	--	--	--
Populus tremuloides	--	--	--	--	--	.5	.5	05
Potentilla fruticosa	--	--	--	--	--	.5	.5	--
Ribes lacustre	--	--	--	--	.5	.5	--	.5
Sedum stenopetalum	--	--	--	.5	--	.5	--	.5
Spiraea lucida	05	--	--	.5	--	--	--	01
BRYOID LAYER								
Candelariella aurella	--	--	--	--	.5	.5	.5	--
Encalypta spp.	--	--	.5	--	.5	.5	--	--
Grimmia spp.	--	--	--	--	--	.5	.5	--
Peltigera spuria	--	--	--	--	.5	.5	--	--
Physcia orbicularis	--	--	--	--	--	.5	.5	--
Pseudoleskeella tectorum	--	--	--	--	.5	--	.5	--
Rhizocarpon disporum	--	--	--	--	--	.5	.5	--
Rhizocarpon geographicum	--	--	--	.5	--	--	.5	--
Tortula ruralis	--	--	--	--	.5	.5	.5	--
Xanthoria elegans	--	--	--	--	.5	.5	.5	--

Some stands have an open physiognomy. In the shrub layer, *Populus tremuloides* (10-20%), *Rosa acicularis* (3-20%) and *Shepherdia canadensis* (1-40%) are dominant and common also are *Juniperus communis* (<1-4%) and *Ribes lacustre* (<5%). The herb-dwarf shrub layer (60-80%) typically contains *Elymus innovatus* (20-50%), *Arctostaphylos uva-ursi* (10-40%), *Aster conspicuus* (10%), *Fragaria virginiana* (1-3%) and *Hedysarum sulphurescens* (1-8%). The bryoid layer is very sparse and epiphytes are scarce.

C22 stands are 40 to 80 years old. Frequent disturbance due to colluviation and snow avalanching seems to be important in maintaining this v.t. It is difficult to categorize successionally because the short period since last disturbance indicates an early or intermediate stage, while the high frequence of disturbance maintains a stable composition, which is characteristic of the mature stage.

C22 differs from C16 in occurring on steep, colluvial rather than gentle, fluvial or morainal landforms. C22 also usually has greater cover of *Aster conspicuus* and *Hedysarum sulphurescens* than C16 and *Lathyrus ochroleucus* which is common in C16 is rare in C22.

Other Studies: C22 is also described in BNP and JNP (Corns and Achuff 1982). In British Columbia, Lea (1984, trembling aspen-soopolallie-pinegrass-fireweed) has a similar type in the East Kootenays. In west central Alberta, Corns (1983) describes a *Populus tremuloides/Viburnum edule/Rubus pubescens* community, Baig (1972) records a *Populus tremuloides/Elymus innovatus* type and Moss (1953) has an aspen poplar consociation in northwestern Alberta.

C23: *Larix lyallii-Abies lasiocarpa/Vaccinium scoparium-Antennaria lanata*

(subalpine larch-subalpine fir/grouseberry-everlasting)

Environment: C23 occurs mostly in the northern half of KNP on mesic Upper Subalpine (2050-2340 m), gentle to moderate slopes of westerly and southerly aspects (Plate 25). Soils are well drained Eutric and Dystric Brunisols on morainal and colluvial landforms.

Vegetation: The closed canopy (15-35%) (Table 32) is dominated by *Larix lyallii* (10-25%) and *Abies lasiocarpa* (3-15%) and often has some *Picea engelmannii* (2-10%). The shrub layer is generally sparse (5-15%) mainly with *Abies lasiocarpa* (1-10%) and *Larix lyallii* (1-5%). The herb-dwarf shrub layer (40-90%) is strongly dominated by *Vaccinium scoparium* (10-70%) with *Antennaria lanata* (<1-3%), *Phyllodoce empetriformis* (10-20%) and *Cassiope mertensiana* (5-10%) also prominant. Species with low cover but high frequency include *Pedicularis bracteosa*, *Senecio triangularis*, *Erigeron peregrinus*, *Viola orbiculata*, *Arnica cordifolia*, *Arnica latifolia*, *Luzula parviflora*, and *Fragaria virginiana*. Diversity of the bryoid layer is high and total cover is usually 5 to 45%. Most common are *Dicranum scoparium* (3-15%), *Barbilophozia lycopodioides* (1-5%), *Pohlia nutans* (<1%), *Polytrichum juniperinum* (1-5%), *Cladonia carneola* (<1%) and *Cladonia ecmocyna* (≤1%). Epiphytes are moderate to abundant, particularly on *Larix lyallii*, with *Letharia vulpina* and *Parmeliopsis* spp. most frequent.

C23 is mature successionally with most stands 100 to >300 years old. C23 is distinguished by the dominance or codominance of *Larix lyallii*. C23 differs from O13 primarily in closed forest *vs.* open forest physiognomy and transitional stands occur. C15, which also has an herb-dwarf shrub layer dominated by *Vaccinium scoparium*, has little or no *Larix lyallii*.

Other Studies: C23 is also described in BNP and JNP (Corns and Achuff 1982). In British Columbia, Kuchar (1978) describes alpine larch forest in Yoho National Park. In Alberta, similar types are described by Trottier and Scotter (1973, *Abies-Picea-Larix/Vaccinium scoparium/Phyllodoce* spp.-*Cassiope mertensiana*, *Larix/Vaccinium scoparium/Trollius albiflorus/Carex nigricans*, *Abies-Picea-Larix/Phyllodoce* spp./*Vaccinium scoparium/Carex nigricans*) in BNP, by Baig (1972) for the southern Rocky Mountains, by Jacques and Legge (1974, spruce-fir-alpine larch/grouseberry) in the Kananaskis area, by Ogilvie (1976, *Picea-Abies- Larix/Luzula wahlenbergii*), and by Kuchar (1973, fir/alpine larch) for Waterton Lakes National Park.

In Montana, Pfister *et al.* (1977) describe alpine larch forest and vegetation described by Arno and Habeck (1972) in the Pacific Northwest of the United States, especially in western Montana, appears quite similar to C23 although no types were recognized *per se*.

Table 32. Stands of the subalpine larch-subalpine fir/grouseberry-everlasting (C23) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	HD	HD	HD	HD	MF	MF	MF	PA	SD	SD
	10	11	11	20	20	20	21	20	20	20
	37	17	25	72	74	80	06	24	30	52
TREE LAYER										
Abies lasiocarpa	05	04	09	30	10	08	10	05	--	10
Larix lyallii	07	09	03	15	07	27	10	20	10	20
Picea engelmannii	03	--	02	05	01	--	--	10	10	--
SHRUB LAYER										
Abies lasiocarpa	05	.5	03	.5	04	10	05	10	--	02
Larix lyallii	02	--	--	--	02	05	--	05	--	03
Picea engelmannii	--	--	--	--	05	--	--	--	02	--
Pinus albicaulis	--	--	.5	--	--	--	--	--	01	--
Salix spp.	--	.5	--	--	01	--	--	--	--	--
HERB-DWARF SHRUB LAYER										
Abies lasiocarpa	.5	.5	--	.5	03	04	02	--	--	--
Antennaria lanata	.5	.5	--	03	--	03	08	.5	03	.5
Arnica cordifolia	--	--	--	--	03	01	15	--	--	05
Arnica latifolia	--	02	--	--	--	--	--	--	--	.5
Carex scirpoidea	--	--	--	--	--	03	--	--	--	05
Cassiope mertensiana	40	--	--	--	--	12	--	--	--	05
Epilobium angustifolium	--	.5	--	--	01	--	02	--	--	--
Erigeron peregrinus	--	10	--	--	--	--	08	05	--	--
Fragaria virginiana	.5	03	--	--	.5	01	01	--	--	01
Larix lyallii	.5	.5	.5	--	01	--	--	--	--	--
Luzula spp.	.5	01	--	--	--	03	03	--	--	03
Pedicularis bracteosa	--	--	--	.5	--	--	01	10	.5	.5
Phyllodoce empetriformis	03	--	--	25	05	17	04	--	--	--
Picea engelmannii	--	--	.5	--	01	--	--	--	02	--
Potentilla diversifolia	--	.5	--	--	--	--	04	--	--	.5
Ranunculus eschscholtzii	01	--	--	--	--	02	--	--	--	02
Senecio triangularis	.5	--	--	--	02	03	--	--	--	--
Sibbaldia procumbens	.5	--	--	--	--	--	.5	--	.5	02
Trollius albiflorus	02	--	--	--	.5	--	--	--	--	03
Vaccinium membranaceum	.5	--	.5	25	04	--	--	--	--	--
Vaccinium scoparium	10	60	80	25	70	19	15	50	50	30
Valeriana sitchensis	--	05	--	--	.5	13	06	.5	--	--
Viola orbiculata	.5	--	--	--	--	--	.5	01	--	--
BRYOID LAYER										
Dicranum scoparium	15	--	--	25	--	--	--	--	--	--
Polytrichum juniperinum	--	07	--	05	--	.5	.5	05	.5	--
Barbilophozia lycopodioides	05	--	--	.5	--	.5	--	--	.5	03
Cladonia carneola	.5	--	.5	.5	--	.5	--	--	--	--
Cladonia ecmocyna	--	--	--	.5	--	--	.5	--	.5	.5
Solorina crocea	--	--	--	03	--	.5	--	--	.5	--
EPIPHYTES										
Bryoria lanestris	--	.5	.5	.5	--	--	--	.5	--	--
Letharia vulpina	.5	.5	.5	.5	--	.5	.5	.5	.5	--
Parmeliopsis ambigua	.5	.5	--	--	--	.5	--	.5	--	.5
Parmeliopsis hyperopta	.5	--	.5	--	--	.5	--	--	--	--

C25: *Picea engelmannii-Abies lasiocarpa/Alnus crispa/Vaccinium membranaceum/Dryopteris assimilis*

(Engelmann spruce-subalpine fir/green alder)

Environment: C25 occurs throughout KNP on mesic Montane and Lower Subalpine (1230-1750 m) sites with moderately sloping, southerly and easterly aspects. Well drained Eutric and Dystric Brunisols occur on colluvial and morainal landforms which are often gullied.

Vegetation: The closed tree canopy (25-60%) (Table 33) is dominated by *Picea* spp. (10-30%), including *Picea glauca*, *Picea engelmannii* and their hybrids, and *Abies lasiocarpa* (5-15%). *Pinus contorta* (5%) and *Pseudotsuga menziesii* (5-10%) also occur in lower elevation stands. The shrub layer is typically dense (40-80%) with *Alnus crispa* (15-30%) dominant. Other common shrubs are *Menziesia glabella* (10-20%), *Abies lasiocarpa* (2-10%) and *Ribes lacustre* (<3%). The herb-dwarf shrub layer is also dense (30-65%) and species-rich. Characteristic species include *Cornus canadensis* (1-10%), *Arnica cordifolia* (2-20%), *Aster conspicuus* (2-4%), *Linnaea borealis* (1-3%), *Rubus parviflorus* (2-5%), *Spiraea lucida* (1-2%) and *Dryopteris assimilis*. *Pleurozium schreberi* (15-50%) and *Hylocomium splendens* (5-15%) dominate the bryoid layer (45-75%). Also common are *Peltigera aphthosa* (1-4%), *Ptilium crista-castrensis* (≤5%), *Drepanocladus uncinatus* (<1%) and *Mnium spinulosum* (<1%). *Bryoria pseudofuscescens*, *Bryoria fuscescens*, *Hypogymnia physodes* and *Parmelia sulcata* are the most frequent epiphytes.

C25 is mature successionally with stand ages of 115 to 300 years. C25 differs from C10, which also has an *Alnus crispa* dominated shrub layer, in having *Picea engelmannii* and *Abies lasiocarpa* as dominant trees.

Other Studies: C25 is also described in MRNP and GNP (Achuff and Dudynsky 1984). Lea (1984, Engelmann spruce-thinleaved mountain alder-heart-leaved arnica) describes a similar type from the East Kootenays of British Columbia.

C28: *Populus balsamifera/Equisetum pratense*

(balsam poplar/horsetail)

Environment: C28 v.t. occurs on subhygric Montane (1290 m) sites in the McKay Creek vicinity. Soils are imperfectly drained Regosolics on nearly level fluvial landforms.

Vegetation: *Populus balsamifera* (35-55%) is dominant in the tree layer (Table 34) and *Picea glauca* (2-10%) is also often present. Shrub cover is variable (10-50%) with *Acer glabrum* (10%), *Cornus stolonifera* (<5%), *Rosa acicularis* (2%) and *Symphoricarpos albus* (8-15%) common. The herb-dwarf shrub layer has high cover (50-80%) and characteristically contains *Equisetum arvense* (5-20%), *Rubus pubescens* (1-5%) and *Galium triflorum* (<1-3%). Bryoid layer cover is generally low (<5%) with *Brachythecium* spp. and *Mnium* spp.

C28 is in an intermediate primary successional stage with stands ≤100 years old. It occurs on sites which are disturbed periodically by flooding. C28 is distinguished by the dominance of *Populus balsamifera*. In KNP, *Populus balsamifera* is difficult to separate from *Populus trichocarpa* since hybridization occurs (Brayshaw 1965) and some workers merge the two taxa (*e.g.* Packer 1983). Flowers or fruits are needed to separate the two taxa and the few collections made in KNP are closest to *Populus trichocarpa*. Thus, *Populus trichocarpa* appears in the species list in Appendix A. However, C28 was first described in BNP and JNP with the name *Populus balsamifera* and the name is retained for the v.t. since both KNP and BNP-JNP stands are one conceptual entity.

Other Studies: C28 is also described in BNP and JNP (Corns and Achuff 1982) and in MRNP and GNP (Achuff and Dudynsky 1984). In west central Alberta, Corns (1983) describes a similar *Populus tremuloides/Rosa acicularis/Thalictrum venulosum* type. In northwestern Alberta, Moss (1953) notes a balsam poplar consociation and in central Saskatchewan, Dix and Swan (1971) describe balsam poplar vegetation.

Table 33. Stands of the Engelmann spruce-subalpine fir/green alder (C25) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	BB	BB	HD	HD	JD	JD	MF	SD
	10	10	11	21	10	10	20	20
	06	36	21	37	05	06	17	26
TREE LAYER								
Abies lasiocarpa	03	15	02	07	--	15	--	20
Picea spp.	--	--	10	25	25	--	08	25
Pinus contorta	--	05	--	--	05	--	05	--
Pseudotsuga menziesii	.5	15	--	--	--	--	05	--
TALL SHRUB LAYER								
Abies lasiocarpa	03	--	07	05	--	--	--	10
Acer glabrum	--	05	--	--	--	02	--	02
Alnus crispa	25	15	04	01	10	18	25	30
SHRUB LAYER								
Abies lasiocarpa	01	--	02	03	--	05	--	10
Lonicera involucrata	02	--	01	.5	--	.5	--	--
Lonicera utahensis	--	--	03	--	--	.5	.5	--
Menziesia glabella	20	10	02	.5	.5	10	--	25
Shepherdia canadensis	--	20	--	--	--	--	03	--
HERB-DWARF SHRUB LAYER								
Amelanchier alnifolia	--	--	--	--	--	02	01	--
Arnica cordifolia	35	05	03	--	01	20	01	--
Aster conspicuus	01	35	04	.5	02	--	02	--
Calamagrostis rubescens	.5	05	--	--	.5	--	04	--
Chimaphila umbellata	--	--	05	.5	.5	--	--	--
Cornus canadensis	05	01	05	10	03	15	01	.5
Fragaria virginiana	.5	--	.5	.5	--	--	01	--
Goodyera oblongifolia	--	--	01	01	--	.5	--	--
Linnaea borealis	15	--	03	.5	02	--	03	.5
Pyrola secunda	--	--	10	.5	.5	.5	.5	.5
Rosa acicularis	--	--	--	--	01	--	03	--
Rubus parviflorus	--	.5	02	08	05	05	--	--
Smilacina racemosa	--	01	--	--	.5	01	--	--
Spiraea lucida	--	05	--	02	01	01	.5	--
Symphoricarpos albus	--	--	--	01	--	--	01	--
BRYOID LAYER								
Drepanocladus uncinatus	.5	.5	.5	03	.5	--	--	--
Hylocomium splendens	45	15	.5	--	10	10	04	10
Mnium spinulosum	.5	.5	.5	.5	--	--	--	--
Pleurozium schreberi	35	15	65	40	50	40	70	05
Polytrichum juniperinum	--	--	.5	.5	.5	--	--	--
Ptilium crista-castrensis	05	--	08	.5	.5	05	.5	--
Ptilidium pulcherrimum	--	.5	--	.5	--	--	.5	--
EPIPHYTES								
Bryoria pseudofuscescens	.5	--	.5	.5	.5	--	--	--
Bryoria fuscescens	.5	.5	--	.5	--	--	--	--
Hypogymnia physodes	.5	--	--	.5	.5	--	.5	.5

C34: *Picea engelmannii-Abies lasiocarpa/Phyllodoce glanduliflora/Hylocomium splendens*

(Engelmann spruce-subalpine fir/heather/feathermoss)

Environment: C34 occurs on mesic Upper Subalpine (2050-2200 m) sites in the Tokumm Creek area in northern KNP on gentle slopes with northerly and easterly aspects. Well to moderately well drained Eutric and Dystric Brunisols and Humo-Ferric Podzols occur on morainal landforms.

Table 34. Stands of the balsam poplar/horsetail (C28) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	IC 70 14	JC 70 01	MF 21 43
TREE LAYER			
Betula papyrifera	--	--	17
Picea glauca	--	02	21
Populus balsamifera	55	33	45
SHRUB LAYER			
Acer glabrum	--	--	09
Cornus stolonifera	.5	.5	04
Lonicera spp.	01	--	05
Picea glauca	02	--	--
Populus balsamifera	15	--	--
Ribes spp.	02	--	09
Rosa acicularis	02	02	--
Symphoricarpos albus	--	08	15
HERB-DWARF SHRUB LAYER			
Actaea rubra	01	--	--
Cornus canadensis	--	--	10
Elymus innovatus	--	02	--
Galium triflorum	.5	.5	03
Mertensia paniculata	01	15	--
Mitella nuda	01	--	05
Osmorhiza spp.	.5	--	04
Petasites palmatus	02	01	--
Rubus pubescens	05	01	02
Vicia americana	01	01	--
Viola rugulosa	--	.5	.5
Equisetum arvense	01	20	05
Equisetum pratense	60	15	--

Vegetation: The tree layer (20-40%) (Table 35) is closed and dominated by *Picea engelmannii* (10-30%) and *Abies lasiocarpa* (5-25%). The shrub layer has total cover of 15 to 30%, mostly of *Abies lasiocarpa* (10-20%) and *Picea engelmannii* (1-5%). The herb-dwarf shrub layer (30-65%) is dominated by *Phyllodoce* spp. (10-50%) and *Cassiope mertensiana* (10-50%) with *Vaccinium scoparium* (5-15%) also common. Herb cover is low. The bryoid layer (30-90%) usually includes *Pleurozium schreberi* (15-45%), *Hylocomium splendens* (10-40%), *Dicranum scoparium* (5-20%), *Barbilophozia lycopodioides* (1-5%) and *Peltigera aphthosa* (1-5%). Epiphytes are moderately abundant with *Letharia vulpina* and *Bryoria* spp. most common.

C34 is successionally mature with stand ages 200 to 400 years. C34 is distinguished from O10 by having a closed forest physiognomy and occurring at slightly lower elevations, from C13 by greater cover of *Phyllodoce* spp., *Cassiope mertensiana* and *Vaccinium scoparium*, and from C15 by the dominance *Phyllodoce* spp. and *Cassiope mertensiana* rather than *Vaccinium scoparium*.

Other Studies: C34 is also described in BNP and JNP (Corns and Achuff 1982). Similar types are not described by other authors.

C37: *Picea glauca/Shepherdia canadensis/Hylocomium splendens*

(white spruce/buffaloberry/feathermoss)

Environment: C37 occurs primarily in the southern portion of KNP on mesic Montane (1150-1410 m), level to gently sloping fluvial and morainal landforms. Soils are commonly well drained Eutric Brunisols.

Table 35. Stands of the Engelmann spruce-subalpine fir/heather/feathermoss (C34) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	JD	KS	PA	PA	PA	PA	PA	MF
	70	60	71	80	80	81	10	20
	97	29	46	64	88	16	74	81
			TREE LAYER					
Abies lasiocarpa	08	05	25	15	10	05	20	20
Picea engelmannii	35	45	15	25	20	35	05	04
			SHRUB LAYER					
Abies lasiocarpa	60	07	25	4C	40	35	10	15
Picea engelmannii	--	30	.5	10	15	05	--	--
	HERB-DWARF SHRUB LAYER							
Abies lasiocarpa	--	--	10	10	--	--	--	04
Arnica cordifolia	.5	04	--	.5	--	--	05	01
Cassiope mertensiana	--	--	20	--	--	--	15	50
Cassiope tetragona	.5	05	--	.5	03	10	--	--
Erigeron peregrinus	--	--	--	.5	--	--	.5	--
Pedicularis bracteosa	.5	10	--	--	.5	--	--	03
Phyllodoce empetriformis	40	--	--	--	--	--	--	04
Phyllodoce glanduliflora	--	25	30	40	20	20	15	--
Vaccinium membranaceum	--	--	--	10	--	--	03	--
Vaccinium scoparium	30	10	02	05	10	05	10	06
			BRYOID LAYER					
Cladonia ecmocyna	03	--	--	.5	05	05	--	.5
Cladonia spp.	03	.5	.5	.5	.5	05	--	08
Dicranum scoparium	02	60	15	05	03	.5	20	03
Drepanocladus uncinatus	--	--	10	05	20	--	--	--
Hylocomium splendens	10	20	.5	40	40	40	--	--
Peltigera aphthosa	02	03	05	15	10	03	--	01
Pleurozium schreberi	75	--	40	30	05	20	--	.5
Pohlia nutans	--	--	--	--	.5	.5	--	15
Barbilophozia hatcheri	--	10	--	.5	.5	05	--	--
Barbilophozia lycopodioides	02	--	20	--	02	--	40	03
				EPIPHYTES				
Bryoria spp.	--	--	.5	.5	.5	.5	.5	.5
Letharia vulpina	.5	--	.5	.5	.5	.5	.5	.5
Usnea spp.	.5	--	--	.5	.5	.5	--	--

Vegetation: *Picea glauca* (15-30%) dominates the tree layer (25-40%) (Table 36). The shrub layer (15-60%) is dominated by *Shepherdia canadensis* (10-40%). *Amelanchier alnifolia*, *Juniperus communis*, *Lonicera involucrata*, *Lonicera utahensis*, *Rosa acicularis* and *Viburnum edule* occur frequently but with cover generally <3%. The herb-dwarf shrub layer (30-60%) is very diverse. Prominent species include *Linnaea borealis* (3-10%), *Aster conspicuus* (3-10%), *Calamagrostis rubescens* (1-10%) and *Cornus canadensis* (5-20%). Species with high frequency but low cover are *Epilobium angustifolium*, *Fragaria virginiana*, *Pyrola secunda*, *Spiraea lucida* and *Arnica cordifolia*. *Pleurozium schreberi* (15-75%) and *Hylocomium splendens* (10-50%) dominate the bryoid layer (40-80%). *Ptilium crista-castrensis* (<1-10%) and *Peltigera aphthosa* (<3%) are also common. Epiphytes are sparse with *Hypogymnia physodes*, *Alectoria sarmentosa* and *Letharia vulpina* common.

C37 stands are 100 to 240 years old. Regeneration of *Picea glauca* is high in all layers indicating a mature successional stage. C37 is distinguished from other v.t.s by the dominance of *Picea glauca* in the tree layer and *Shepherdia canadensis* in the shrub layer.

Other Studies: C37 is also described in BNP and JNP (Corns and Achuff 1982). No similar types

Table 36. Stands of the white spruce/buffaloberry/feathermoss (C37) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	PA	HD	JD	JD	JD	MF	MF	PA	PA	SD
	20	20	10	10	20	20	20	10	10	20
	11	46	15	16	05	10	72	01	02	42
TREE LAYER										
Abies lasiocarpa	--	--	01	02	--	--	--	--	05	--
Picea glauca	20	05	19	23	20	30	10	25	25	20
Pinus contorta	01	03	--	--	05	--	05	10	--	--
Pseudotsuga menziesii	--	--	05	--	01	--	05	--	15	--
SHRUB LAYER										
Abies lasiocarpa	01	--	--	04	08	--	--	--	05	--
Amelanchier alnifolia	.5	--	.5	01	.5	--	04	.5	.5	02
Juniperus communis	15	01	03	--	02	03	03	.5	.5	.5
Menziesia glabella	01	--	01	25	03	--	--	--	--	--
Picea glauca	15	5	03	15	--	16	15	01	12	--
Pseudotsuga menziesii	--	--	.5	--	02	--	05	--	--	--
Shepherdia canadensis	30	15	40	25	02	04	40	40	10	05
Viburnum edule	--	--	--	--	--	.5	03	--	--	01
HERB-DWARF SHRUB LAYER										
Arctostaphylos uva-ursi	--	03	--	--	02	--	--	--	--	.5
Arnica cordifolia	--	.5	03	01	--	--	--	.5	01	--
Aster ciliolatus	.5	.5	01	--	--	--	01	.5	--	--
Aster conspicuus	03	10	20	03	--	--	05	20	10	.5
Calamagrostis rubescens	.5	30	15	10	05	--	--	.5	01	03
Cornus canadensis	.5	20	10	02	03	01	04	20	10	05
Elymus innovatus	--	--	--	--	--	15	10	--	--	--
Epilobium angustifolium	--	.5	.5	.5	--	.5	.5	.5	--	.5
Fragaria virginiana	.5	03	--	.5	01	02	05	02	02	.5
Galium boreale	--	.5	--	--	--	.5	02	.5	--	.5
Geocaulon lividum	--	03	--	--	.5	--	--	--	.5	--
Hedysarum sulphurescens	--	.5	.5	--	--	.5	.5	--	--	--
Linnaea borealis	10	05	02	05	02	04	10	03	03	05
Lonicera involucrata	--	--	--	.5	--	03	02	.5	--	--
Lonicera utahensis	--	--	.5	.5	01	--	--	.5	.5	--
Oryzopsis asperifolia	--	.5	--	--	--	.5	02	.5	--	--
Pyrola secunda	--	.5	.5	--	01	01	--	.5	.5	--
Pyrola virens	03	--	.5	--	.5	--	--	.5	.5	--
Rosa acicularis	02	04	.5	.5	--	14	11	02	01	02
Rubus pubescens	--	.5	--	--	--	02	04	.5	--	.5
Spiraea lucida	--	03	01	01	01	--	01	.5	.5	--
Vaccinium caespitosum	01	02	03	--	--	--	20	01	.5	--
Vaccinium scoparium	--	--	15	08	06	--	--	--	--	--
BRYOID LAYER										
Dicranum polysetum	--	--	.5	.5	--	--	--	.5	.5	--
Dicranum scoparium	02	03	--	--	01	.5	--	--	--	--
Hylocomium splendens	30	50	10	08	35	20	08	30	45	10
Pleurozium schreberi	35	20	70	75	45	16	06	45	40	10
Ptilium crista-castrensis	.5	.5	05	02	--	01	--	10	--	05
Peltigera aphthosa	01	03	01	01	.5	03	01	03	05	.5
EPIPHYTES										
Alectoria sarmentosa ssp. sarmentosa	.5	--	--	.5	.5	--	--	--	.5	.5
Hypogymnia physodes	--	--	--	--	--	.5	.5	.5	.5	.5
Letharia vulpina	.5	--	--	.5	.5	--	--	--	.5	.5
Parmeliopsis ambigua	--	--	--	--	.5	.5	--	--	.5	--

are described by other authors in British Columbia. In Alberta, La Roi (1967, part of white spruce-fir) and Kondla (1978, spruce-fir/buffaloberry-grouseberry) describe similar types.

C38: *Pinus contorta/Shepherdia canadensis/Calamagrostis rubescens/Pleurozium schreberi*

(lodgepole pine/buffaloberry/pinegrass)

Environment: C38 occurs on mesic Montane (1100-1440 m) sites on gentle southerly and westerly aspects on lower slopes and terraces of the lower Vermilion and Kootenay valleys. The soils are well drained Eutric Brunisols and Gray Luvisols on morainal and fluvial landforms.

Vegetation: The closed tree layer (20-50%) is dominated by *Pinus contorta* (10-40%) with *Picea glauca* and *Pseudotsuga menziesii* often present with low cover (Table 37, Plates 5 and 22). *Shepherdia canadensis* (10-40%) dominates the shrub layer (10-40%). *Rosa acicularis* (1-5%), *Juniperus scopulorum* (<5%), and *Picea glauca* (1-5%) are common. The herb-dwarf shrub layer is usually dense (30-85%) and is dominated by *Calamagrostis rubescens* (10-40%). Also often present are *Linnaea borealis* (3-10%), *Fragaria virginiana* (1-5%), *Aster conspicuus* (1-5%), *Spiraea lucida* (1-5%), *Arnica cordifolia* (1-3%) and *Cornus canadensis* (1-5%). Species with high frequency but low cover include *Pyrola secunda*, *Arctostaphylos uva-ursi*, *Aster ciliolatus*, *Epilobium angustifolium*, *Hedysarum sulphurescens* and *Chimaphila umbellata*. The bryoid layer (25-85%) is dominated by *Pleurozium schreberi* (20-60%) with *Hylocomium splendens* (10-30%), *Peltigera aphthosa* (1-5%), *Ptilium crista-castrensis* (<5%) and *Dicranum* spp. (<1%) also commonly present. Epiphytes are generally scarce with *Cetraria canadensis*, *Hypogymnia physodes*, *Letharia vulpina* and *Bryoria fuscescens* most common.

Stand ages are 55 to 120 years. The presence of *Picea glauca* and *Pseudotsuga menziesii* regeneration in the understory indicates that C38 is intermediate to advanced successionally and suggests possible succession to C5.

C38 is closely related to C3, C6, C9, C18, C19 and C39. C38 differs primarily by having *Calamagrostis rubescens* dominant in the herb-dwarf shrub layer (Table 17).

Other Studies: In British Columbia, Lea (1984) describes several similar types (lodgepole pine-Rocky Mountain maple-soopolallie-pine grass, lodgepole pine-white spruce-soopolallie-pine grass, lodgepole pine-soopolallie-pine grass-fireweed) in the East Kootenays of British Columbia. Steele *et al.* (1983) describe a similar *Pinus contorta/Shepherdia canadensis* type in Idaho and Wyoming.

C39: *Pinus contorta/Shepherdia canadensis/Cornus canadensis/Pleurozium schreberi*

(lodgepole pine/buffaloberry/bunchberry)

Environment: C39 occurs on mesic Montane sites (1120-1500 m) mostly in the Kootenay and lower Vermilion river valleys on various slopes and aspects. The soils are well drained Eutric Brunisols on fluvial and morainal landforms.

Vegetation: The closed tree layer (20-75%) is dominated by *Pinus contorta* (15-70%) (Table 38). *Picea glauca* and *Populus tremuloides* occur with low cover in many stands. *Shepherdia canadensis* (10-30%) dominates the shrub layer (15-50%). *Rosa acicularis* (1-4%), *Menziesia glabella* (1-3%) and *Amelanchier alnifolia* (1%) are also often present. The herb-dwarf shrub layer (15-60%) is dominated by *Cornus canadensis* (10-25%). Other characteristic species include *Calamagrostis rubescens* (2-10%), *Aster conspicuus* (1-5%), *Linnaea borealis* (1-3%), *Fragaria virginiana* (1-3%) and *Arnica cordifolia* (1-3%). Species with low cover but high frequency include *Aster ciliolatus*, *Epilobium angustifolium*, *Lonicera involucrata*, *Oryzopsis asperifolia*, *Pyrola secunda* and *Viburnum edule*. The bryoid layer (35-90%) is dominated by *Pleurozium schreberi* (30-50%) with lesser amounts of *Hylocomium splendens* (10-30%), *Ptilium crista-castrensis* (5-10%) and *Peltigera aphthosa* (<5%). Epiphytes are scarce to moderate with *Hypogymnia physodes*, *Bryoria fremontii* and *Alectoria sarmentosa* most common.

Table 37. Stands of the lodgepole pine/buffaloberry/pine grass (C38) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	HD 20 25	JD 10 18	JD 10 32	JD 20 01	PA 10 04	PA 20 07	PA 20 14	PA 20 19	PA 20 22	SD 20 43
					TREE LAYER					
Picea glauca	--	.5	.5	.5	.5	.5	--	02	--	--
Pinus contorta	20	40	30	40	35	35	38	40	40	38
Pseudotsuga menziesii	--	--	--	--	--	13	--	03	--	--
					SHRUB LAYER					
Juniperus communis	.5	--	--	--	05	.5	02	--	--	--
Juniperus scopulorum	--	--	--	--	--	--	--	10	01	--
Lonicera utahensis	.5	02	--	--	--	--	.5	.5	.5	--
Picea glauca	.5	--	--	.5	--	--	.5	--	.5	--
Pseudotsuga menziesii	--	--	--	--	--	10	.5	25	.5	--
Shepherdia canadensis	10	15	10	35	15	30	35	20	30	10
					HERB DWARF SHRUB LAYER					
Arctostaphylos uva-ursi	02	--	.5	.5	02	--	--	10	--	--
Arnica cordifolia	02	01	.5	02	01	.5	01	--	10	03
Aster ciliolatus	--	01	--	.5	.5	--	01	--	--	.5
Aster conspicuus	02	01	.5	--	--	03	01	03	10	.5
Calamagrostis rubescens	35	40	35	40	20	10	15	10	20	10
Calypso bulbosa	--	.5	--	.5	--	.5	.5	--	--	--
Chimaphila umbellata	.5	.5	.5	.5	.5	--	.5	.5	.5	--
Cornus canadensis	02	05	.5	03	07	.5	03	01	02	03
Elymus innovatus	--	--	--	02	--	.5	01	--	--	--
Epilobium angustifolium	--	.5	--	.5	--	.5	--	--	.5	.5
Fragaria virginiana	.5	01	.5	01	01	01	02	05	05	--
Galium boreale	--	--	--	--	.5	.5	--	--	--	--
Hedysarum sulphurescens	01	--	25	.5	05	.5	--	.5	.5	--
Linnaea borealis	05	20	10	.5	03	.5	05	10	05	05
Oryzopsis asperifolia	--	--	--	--	--	02	--	02	--	--
Picea glauca	.5	.5	--	--	--	--	.5	.5	--	--
Pyrola secunda	.5	.5	.5	.5	.5	--	.5	.5	--	.5
Pyrola virens	--	--	.5	--	.5	--	01	--	.5	03
Rosa acicularis	05	01	01	.5	.5	05	03	05	03	05
Spiraea lucida	05	02	.5	01	--	05	.5	02	08	05
Symphoricarpos albus	15	--	01	--	--	.5	01	--	.5	.5
Vaccinium caespitosum	--	.5	05	01	.5	03	02	--	.5	--
Lycopodium annotinum	--	--	--	--	--	--	.5	--	.5	01
					BRYOID LAYER					
Dicranum spp.	--	.5	.5	.5	.5	.5	--	--	--	--
Hylocomium splendens	--	--	20	01	40	30	25	25	05	--
Pleurozium schreberi	15	80	50	83	45	50	55	45	50	20
Ptilium crista-castrensis	--	03	.5	.5	--	.5	--	--	--	--
Cladonia spp.	.5	.5	.5	.5	.5	--	.5	.5	--	.5
Peltigera aphthosa	05	.5	01	01	03	.5	05	10	--	.5
					EPIPHYTES					
Bryoria fremontii	--	.5	--	.5	.5	.5	--	--	.5	--
Bryoria spp.	--	.5	.5	.5	.5	.5	--	.5	.5	--
Cetraria canadensis	--	.5	.5	.5	.5	.5	--	.5	.5	--
Hypogymnia physodes	--	--	--	.5	.5	.5	--	.5	.5	--
Letharia vulpina	--	--	--	.5	.5	.5	--	.5	.5	--

Table 38. Stands of the lodgepole pine/buffaloberry/bunchberry (C39) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	BB	JD	JD	MF	MF	MF	PA	PA	PA
	10	10	20	20	20	20	10	10	10
	01	17	09	36	46	48	03	67	68
TREE LAYER									
Abies lasiocarpa	--	--	.5	--	--	--	--	.5	.5
Picea glauca	05	01	11	05	--	--	06	08	10
Pinus contorta	13	28	19	70	40	50	35	27	15
SHRUB LAYER									
Abies lasiocarpa	--	--	.5	--	--	--	--	10	09
Amelanchier alnifolia	.5	--	01	01	01	--	--	.5	.5
Juniperus communis	03	.5	.5	--	--	01	01	--	--
Menziesia glabella	.5	--	02	03	02	.5	01	15	05
Picea glauca	-	10	01	11	--	08	10	05	01
Salix scouleriana	--	02	.5	--	.5	02	02	--	--
Shepherdia canadensis	30	40	60	30	14	22	33	15	15
HERB-DWARF SHRUB LAYER									
Arnica cordifolia	.5	30	01	03	03	13	.5	--	--
Aster ciliolatus	.5	--	--	01	.5	--	.5	--	03
Aster conspicuus	.5	03	01	10	03	13	.5	05	05
Calamagrostis rubescens	10	05	03	19	06	04	02	.5	--
Cornus canadensis	15	10	05	26	18	17	05	15	25
Elymus innovatus	.5	--	.5	--	--	--	.5	--	01
Epilobium angustifolium	10	.5	--	01	01	01	.5	--	--
Fragaria virginiana	08	05	01	10	--	--	01	--	01
Hedysarum sulphurescens	--	.5	--	.5	--	02	.5	--	--
Linnaea borealis	.5	.5	01	03	02	02	02	10	--
Lonicera involucrata	--	02	.5	5	--	--	--	.5	.5
Lonicera utahensis	--	01	02	02	02	03	.5	.5	--
Oryzopsis asperifolia	.5	--	--	--	.5	--	01	.5	.5
Pyrola secunda	--	.5	.5	.5	.5	01	--	.5	.5
Rosa acicularis	.5	02	02	05	04	03	03	.5	01
Spiraea lucida	--	.5	--	01	01	02	.5	02	--
Vaccinium caespitosum	05	.5	01	.5	03	01	.5	--	--
Viburnum edule	.5	02	01	.5	.5	--	--	--	.5
Lycopodium annotinum	--	.5	.5	--	--	--	.5	.5	--
BRYOID LAYER									
Dicranum polysetum	.5	01	.5	--	--	--	05	--	--
Hylocomium splendens	35	.5	60	05	06	--	30	20	30
Pleurozium schreberi	45	75	20	25	38	21	30	30	50
Ptilium crista-castrensis	.5	03	05	.5	--	05	25	30	10
Cladonia spp.	.5	--	.5	--	--	--	.5	.5	.5
Peltigera aphthosa	03	01	.5	.5	01	04	--	.5	05
EPIPHYTES									
Bryoria fremontii	.5	--	.5	--	--	--	.5	--	--
Alectoria sarmentosa ssp. sarmentosa	--	--	.5	--	--	--	--	.5	.5
Hypogymnia physodes	--	.5	.5	.5	.5	.5	--	--	--
Letharia vulpina	--	--	.5	--	.5	.5	--	--	--
Parmeliopsis ambigua	.5	.5	--	--	--	--	.5	--	--
Bryoria spp.	.5	.5-	--	.5	.5	.5	.5	.5	.5

Stand ages are 60 to 165 years and C39 is intermediate successionally. Stands are of fire origin and abundant *Picea glauca* regeneration in the understory indicates further succession to *Picea* dominated forest.

C39 is closely related to C3, C6, C9, C18, C19 and C38. C39 differs primarily by having *Cornus canadensis* dominant in the herb-dwarf shrub layer (Table 17).

Other Studies: In eastern British Columbia, Lea (1984, lodgepole pine-soopolallie-Canadian bunchberry-grouseberry) describes a similar type.

C40: *Picea engelmannii-Abies lasiocarpa/Oplopanax horridum*/fern

(Engelmann spruce-subalpine fir/devil's club/fern)

Environment: C40 occurs on subhygric Montane to Lower Subalpine (1100-1400 m) sites on gentle slopes of various aspect in lower slope positions in the Kootenay and Vermilion river valleys. Only one stand, near Vérendrye Creek, was sampled. C40 occurs usually as small patches in areas with a high water table due to groundwater discharge. Soils are moderately well drained Eluviated Eutric Brunisols on fluvial landforms.

Vegetation: *Picea engelmannii* (15%) and *Abies lasiocarpa* (5%) comprise the tree layer (Table 39) and *Oplopanax horridum* (15%), along with *Menziesia glabella* (5%) and *Sambucus pubens* (5%), characterize the shrub layer (20%). In the herb-dwarf shrub layer, *Dryopteris assimilis* (10%) and *Gymnocarpium dryopteris* (10%) are codominant with *Tiarella unifoliata* (10%) and *Rubus parviflorus* (8%). Also important are *Actaea rubra*, *Galium triflorum* and *Equisetum arvense* (3%). *Brachythecium curtum* (10%), *Mnium* spp. (15%), *Drepanocladus uncinatus* (5%) and *Pleurozium schreberi* (5%) are the major components in the species-poor bryoid layer. Epiphytes are scant.

Table 39. Stands of the Engelmann spruce-subalpine fir/devil's club/fern (C40) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	HD 10 35
	TREE LAYER
Abies lasiocarpa	05
Picea engelmannii	15
	SHRUB LAYER
Menziesia glabella	05
Oplopanax horridum	12
Sambucus pubens	05
	HERB-DWARF SHRUB LAYER
Actaea rubra	05
Galium triflorum	05
Rubus parviflorus	08
Rubus strigosus	05
Tiarella unifoliata	10
Dryopteris assimilis	10
Equisetum arvense	03
Gymnocarpium dryopteris	10
	BRYOID LAYER
Brachythecium curtum	10
Drepanocladus uncinatus	05
Pleurozium schreberi	05
Mnium sp.	15

C40 is successionally mature with stands ≥150 years old. C40 is distinguished by the dominance of *Oplopanax horridum* in the shrub layer. It often occurs in association with C42.

Other Studies: In British Columbia, Eis (1980) describes a devil's club site type near Prince George which appears similar. Wali and Krajina (1973) describe a similar *Abies lasiocarpa-Picea engelmannii/Oplopanax horridum/Gymnocarpium dryopteris* type.

C41: *Picea glauca-Abies lasiocarpa/Cornus canadensis-Equisetum arvense/Hylocomium splendens*

(white spruce-subalpine fir/bunchberry-horsetail)

Environment: C41 occurs on mesic to subhygric Montane (1250-1430 m) sites between Vermilion Peak and Mount Shanks (Plate 56). Soils are moderately well to imperfectly drained Regosolics on gently sloping fluvial landforms with westerly aspects. Only two stands were sampled.

Table 40. Stands of the white spruce-subalpine fir/bunchberry-horsetail (C41) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	HD	HD
	10	20
	09	37
TREE LAYER		
Abies lasiocarpa	02	--
Picea glauca	10	10
SHRUB LAYER		
Abies lasiocarpa	05	.5
Amelanchier alnifolia	.5	--
Lonicera dioica	02	--
Lonicera involucrata	05	01
HERB-DWARF SHRUB LAYER		
Cornus canadensis	20	03
Elymus innovatus	.5	05
Erigeron compositus	--	.5
Linnaea borealis	05	03
Mitella nuda	01	01
Pyrola secunda	.5	02
Rosa acicularis	05	01
Rubus pubescens	.5	02
Equisetum arvense	20	--
Equisetum pratense	--	30
Lycopodium annotinum	10	--
BRYOID LAYER		
Hylocomium splendens	70	30
Ptilium crista-castrensis	05	05
Ptilidium pulcherrimum	--	18
Peltigera aphthosa	.5	.5
EPIPHYTES		
Bryoria fuscescens	--	.5
Hypogymnia enteromorpha	--	.5
Letharia vulpina	--	.5

Vegetation: *Picea glauca* (10%) dominates the tree layer (10-15%) (Table 40). The shrub layer is extremely sparse consisting mainly of *Lonicera involucrata* (5%) and *Lonicera dioica* (2%). The herb-dwarf shrub layer is dominated by *Equisetum* spp. (20-30%) with *Cornus canadensis* (3-20%), *Fragaria virginiana* (2-5%), *Linnaea borealis* (3-5%), *Mitella nuda* (4%), *Petasites palmatus* (5%), *Pyrola secunda* (0.5-2%), *Rosa acicularis* (1-5%) and *Rubus pubescens* (0.5-2%). *Hylocomium* *splendens* (30-70%), *Pleurozium schreberi* (25%) and *Ptilium crista-castrensis* (5%) and *Peltigera aphthosa* (<1%) are common in the bryoid layer.

C41 is successionally mature with stands 130 to 240 years old. C41 is distinguished by its very sparse shrub layer and dominance of the herb-dwarf shrub layer by *Equisetum arvense*.

Other Studies: In British Columbia, Eis (1980) has a similar type (*Cornus*-moss) near Prince George, and Kujala (1945) describes a similar *Mitella-Equisetum* type. In Alberta, similar types are noted by Corns (1983, *Picea engelmannii/Equisetum arvense/Hylocomium splendens*) and Lesko and Lindsay (1973, white spruce/horsetail).

C42: *Thuja plicata/Vaccinium ovalifolium*

(western red cedar/oval leaf blueberry)

Environment: C42 occurs on subhygric Montane to Lower Subalpine (1100-1570 m) sites in the Kootenay and Vermilion valleys, north to Vérendrye Creek, and along Sinclair and McKay creeks. Soils are moderately well drained Eutric Brunisols on colluvial and morainal landforms with moderate to steep slopes of various aspects.

Vegetation: *Thuja plicata* (15-60%) comprises nearly all of the tree layer (20-60%) along with *Picea glauca* (1-5%) and *Pseudotsuga menziesii* (8-10%) (Table 41). The shrub layer has total cover of 15 to 25% with *Thuja plicata* regeneration (10-15%), *Acer glabrum* (1-4%), *Menziesia glabella* (≤1%) and *Ribes lacustre* (1-3%) most common. Herb-dwarf shrub layer cover is generally <35% and species have low cover. These include *Vaccinium ovalifolium* (5-25%), *Mitella nuda* (1-3%), *Thuja plicata* regeneration (1-3%), *Gymnocarpium dryopteris* (2-15%), *Cornus canadensis* (<2%), *Actaea rubra* (<1%) and *Smilacina racemosa* (<1%). Cover of the bryoid layer is variable (10-80%) with *Hylocomium splendens*, *Ptilium crista-castrensis*, *Pleurozium schreberi*, *Peltigera aphthosa* and *Dicranum fuscescens* most common. Epiphytes are moderately to sparsely abundant with *Hypogymnia physodes* and *Cetraria pinastri* characteristic.

Other Studies: No similar types are described by other authors.

C44: *Picea* spp.-*Populus tremuloides*-*Pinus contorta*-(*Betula papyrifera*)/*Shepherdia canadensis*/*Calamagrostis rubescens*

(spruce-aspen-lodgepole pine-(paper birch)/buffaloberry/pine grass)

Environment: C44 occurs on mesic to subhygric Montane (1110-1480 m) sites in the southern half of KNP. Slopes and aspects vary widely. Rapidly to moderately well drained Eutric Brunisols occur on morainal and fluvial landforms.

Vegetation: C44 is a mixedwood forest (Plate 27) with *Picea glauca* (5-35%), *Pinus contorta* (5-45%), *Pseudotsuga menziesii* (3-15%), *Betula papyrifera* (2-10%) and *Populus tremuloides* (1-25%) in the tree layer (Table 42). The shrub layer is dense (30-70%) and dominated by *Shepherdia canadensis* (15-35%). Also important are *Rosa acicularis* (3-5%), *Lonicera utahensis* (1-5%), *Picea glauca* (1-5%) and *Amelanchier alnifolia* (1-2%). The herb-dwarf shrub layer is dense (50-90%) and species-rich with no single species clearly dominant. However, prominent species include *Calamagrostis rubescens* (3-15%), *Linnaea borealis* (3-15%), *Cornus canadensis* (3-10%), *Aster conspicuus* (1-5%), *Arnica cordifolia* (≤10%), *Fragaria virginiana* (1-5%), *Epilobium angustifolium* (<1%) and *Spiraea lucida* (1-10%). Bryoid layer cover is variable (5-80%) as are individual species values. Important species include *Pleurozium schreberi*, *Hylocomium splendens*, *Ptilium crista-castrensis*, *Peltigera aphthosa* and *Brachythecium* spp. Epiphytes are moderately abundant with *Hypogymnia physodes*, *Letharia vulpina* and *Bryoria fuscescens* typical.

Stand ages are mostly 100 to 150 years and C44 is successionally intermediate. Regeneration of *Picea glauca* is high suggesting succession towards a climax *Picea glauca* community. C44 is distinguished by its mixed deciduous-coniferous tree composition. Stands transitional to C16 may occur where coniferous species have low cover.

Table 41. Stands of the western red cedar/oval leaf blueberry (C42) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	HD	HD	HD	MF	MF	MF	SD
	10	10	21	21	21	21	20
	36	40	40	44	45	46	07
TREE LAYER							
Abies lasiocarpa	01	20	.5	--	--	06	--
Picea glauca	.5	02	01	--	--	--	05
Pseudotsuga menziesii	--	--	--	09	08	05	--
Thuja plicata	14	08	60	07	41	25	20
TALL SHRUB LAYER							
Acer glabrum	--	--	--	04	04	--	--
Alnus crispa	--	--	--	03	--	03	--
Thuja plicata	15	09	05	01	11	20	10
SHRUB LAYER							
Cornus stolonifera	--	--	--	04	--	02	--
Oplopanax horridum	--	.5	02	--	02	--	--
Ribes lacustre	--	--	02	03	--	01	--
Thuja plicata	10	05	06	02	05	18	05
HERB-DWARF SHRUB LAYER							
Actaea rubra	--	--	.5	--	.5	.5	.5
Arnica cordifolia	--	02	--	--	--	.5	.5
Cornus canadensis	--	01	.5	06	--	02	.5
Galium triflorum	--	02	--	.5	.5	--	--
Glyceria pauciflora	--	--	--	02	--	.5	--
Linnaea borealis	--	--	--	06	--	04	--
Mitella nuda	--	--	04	03	.5	01	.5
Pyrola secunda	--	--	--	04	--	01	--
Rubus parviflorus	--	01	--	--	--	.5	--
Smilacina racemosa	--	--	.5	.5	.5	.5	--
Streptopus amplexifolius	--	01	--	--	.5	--	--
Thuja plicata	01	.5	--	01	03	.5	--
Tiarella unifoliata	--	10	05	--	--	--	.5
Vaccinium membranaceum	--	20	.5	--	--	--	--
Vaccinium ovalifolium	.5	25	05	--	--	--	03
Gymnocarpium dryopteris	--	15	20	--	02	--	02
Lycopodium annotinum	--	--	.5	05	--	--	01
BRYOID LAYER							
Dicranum fuscescens	--	01	--	.5	--	.5	.5
Hylocomium splendens	30	--	--	30	.5	68	05
Mnium spinulosum	--	--	.5	--	.5	--	.5
Pleurozium schreberi	--	.5	35	30	--	05	03
Ptilium crista-castrensis	04	--	05	10	--	05	.5
Barbilophozia lycopodioides	--	30	.5	--	--	--	02
Cladonia spp.	.5	.5	.5	--	--	.5	--
Peltigera aphthosa	03	03	--	05	--	04	.5
EPIPHYTES							
Alectoria sarmentosa ssp. sarmentosa	.5	--	.5	--	--	--	.5
Cetraria pinastri	.5	--	--	--	--	.5	.5
Hypogymnia physodes	--	.5	--	.5	.5	.5	.5
Parmeliopsis hyperopta	--	.5	.5	--	--	--	.5

Table 42. Stands of the spruce-aspen-lodgepole pine-(paper birch)/buffaloberry/pine grass (C44) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	BB	BB	JD	JD	MF	MF	PA	PA	PA	SD
	10	10	20	20	20	20	10	20	20	20
	17	18	06	07	20	31	05	16	17	41
TREE LAYER										
Betula papyrifera	.5	10	10	02	05	10	--	--	--	--
Picea glauca	15	15	05	13	29	03	05	15	--	06
Pinus contorta	10	05	10	10	28	06	05	15	04	13
Populus tremuloides	05	.5	02	01	--	15	25	20	21	01
Pseudotsuga menziesii	--	--	01	--	03	16	--	--	.5	.5
SHRUB LAYER										
Acer glabrum	--	--	35	07	--	17	--	.5	--	--
Amelanchier alnifolia	--	--	.5	02	06	.5	.5	01	--	03
Betula papyrifera	02	03	05	08	05	.5	--	--	--	--
Juniperus communis	--	--	--	--	07	02	05	03	--	11
Ledum groenlandicum	01	10	01	35	--	--	.5	--	--	--
Lonicera utahensis	--	--	01	01	05	02	--	.5	--	--
Menziesia glabella	--	.5	02	02	--	20	--	--	01	--
Picea glauca	05	04	01	03	10	05	.5	.5	.5	10
Shepherdia canadensis	35	30	20	40	25	10	25	45	35	20
HERB-DWARF SHRUB LAYER										
Aralia nudicaulis	.5	.5	.5	--	.5	--	--	--	--	--
Arctostaphylos uva-ursi	--	--	--	--	--	--	.5	--	10	.5
Arnica cordifolia	--	.5	01	.5	--	15	--	15	10	.5
Aster conspicuus	03	01	.5	.5	01	19	--	20	10	--
Calamagrostis rubescens	10	08	.5	--	03	10	20	03	35	15
Clematis verticellaris	.5	--	.5	--	--	01	--	.5	.5	--
Cornus canadensis	05	10	05	.5	03	03	10	10	--	02
Elymus innovatus	--	--	01	10	--	02	05	05	--	.5
Epilobium angustifolium	--	--	--	.5	--	01	.5	05	03	.5
Fragaria virginiana	.5	--	--	.5	--	--	10	05	05	02
Linnaea borealis	08	08	02	.5	26	04	25	10	05	05
Lonicera involucrata	--	.5	01	.5	01	--	--	.5	02	--
Oryzopsis asperifolia	.5	--	--	.5	10	02	--	--	.5	--
Osmorhiza spp.	.5	.5	--	--	.5	01	--	.5	02	--
Pyrola spp.	--	--	.5	.5	01	--	.5	--	--	01
Ribes lacustre	.5	01	01	04	--	05	--	.5	--	--
Rosa acicularis	15	.5	01	.5	20	02	03	05	03	04
Rubus parviflorus	.5	01	--	--	02	.5	--	--	--	--
Rubus pubescens	05	--	--	--	.5	--	01	--	--	--
Spiraea lucida	01	01	06	10	--	01	.5	05	15	--
Vaccinium caespitosum	15	--	--	05	--	--	.5	--	--	.5
Vaccinium membranaceum	--	20	08	15	--	10	--	--	--	--
Viburnum edule	03	01	02	01	02	03	.5	.5	--	--
Lycopodium annotinum	.5	--	.5	25	--	01	--	--	--	--
BRYOID LAYER										
Brachythecium spp.	--	--	--	--	--	--	03	10	05	02
Hylocomium splendens	55	50	30	40	04	--	--	--	--	--
Pleurozium schreberi	15	20	45	40	20	10	.5	.5	--	03
Ptilium crista-castrensis	05	.5	05	05	--	--	.5	--	--	--
Cladonia spp.	.5	--	--	.5	--	--	.5	--	--	--
Peltigera aphthosa	01	03	02	.5	01	--	--	.5	--	.5
EPIPHYTES										
Bryoria fuscescens	--	.5	.5	.5	--	--	.5	--	--	.5
Cetraria spp.	.5	--	.5	.5	--	.5	.5	--	--	.5
Hypogymnia physodes	.5	--	.5	--	--	.5	--	--	--	.5

Other Studies: C44 is also described in MRNP and GNP (Achuff and Dudynsky 1984). Eis (1980) describes a similar *Aralia-Dryopteris* site type near Prince George, British Columbia, Clement (1981) has a Rocky Mountain Douglas fir-common paper birch-birch-leaved spiraea-large-leaved rattlesnake orchid type near Vernon, and Lea (1984) notes a lodgepole pine-trembling aspen-birch-leaved spirea-pine grass-grouseberry type.

C45: *Picea glauca-Larix occidentalis-Pseudotsuga menziesii/Cornus canadensis/Pleurozium schreberi*

(white spruce-western larch-Douglas fir/bunchberry)

Environment: C45 occurs on mesic Montane (1170-1210 m) sites in southern KNP mainly along Settlers Road. Soils are moderately well drained Eutric Brunisols on morainal landforms with gentle to moderate slopes of various aspects.

Vegetation: C45 is characterized by a mixed coniferous tree layer (Table 43) composed of *Picea glauca, Larix occidentalis, Pseudotsuga menziesii* and *Pinus contorta*. The shrub layer is sparse with *Shepherdia canadensis, Acer glabrum* and *Pseudotsuga menziesii* common. The herb-dwarf shrub layer (55-70%) is species-rich and includes *Arnica cordifolia* (2%), *Cornus canadensis* (7-12%), *Thalictrum occidentale* (5-10%) and *Rubus parviflorus* (1-2%). Other characteristic species are *Aralia nudicaulis, Calamagrostis rubescens, Disporum trachycarpum, Linnaea borealis, Lonicera involucrata, Rosa acicularis, Mitella nuda, Smilacina racemosa* and *Spiraea lucida*. Major bryoid layer species are *Pleurozium schreberi, Ptilium crista-castrensis* and *Hylocomium splendens*. Epiphytes are scarce.

Stand ages are 60 to 110 years and C44 is advanced successionally. The presence of *Larix occidentalis* and *Pinus contorta* indicates that C44 originates after fire and that long term succession is perhaps to C5. C44 is distinguished by *Larix occidentalis* in the tree layer and the range of this v.t. is limited to southern KNP by the range of *Larix occidentalis*. Further information on the range of *Larix occidentalis* is in the *Significant Botanical Features* section below.

Other Studies: No similar types are described by other authors.

OPEN FOREST VEGETATION TYPES

O4: *Picea engelmannii-Abies lasiocarpa-Pinus albicaulis-Pinus contorta*

(Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine)

Environment: O4 occurs throughout KNP on subxeric to mesic, Lower to Upper Subalpine (1920-2290 m), steeply sloping sites with southerly to westerly aspects. Soils are rapidly to well drained Brunisolics and Regosolics on colluvial landforms. The soils are often shallow to bedrock and bedrock outcrops are common. Some sites are snow avalanched.

Vegetation: *Picea engelmannii* (5-10%), *Abies lasiocarpa* (1-3%) and *Pinus albicaulis* (1-10%) dominate the open tree layer (Table 44) of this heterogeneous, mixed coniferous v.t. which generally has tree cover of <20% (Plate 63). The shrub layer (5-20%) contains *Shepherdia canadensis* (2-20%), *Juniperus communis* (1-5%) and *Potentilla fruticosa* (1-3%). Prominent species in the herb-dwarf shrub layer include *Achillea millefolium* (<1-2%), *Arctostaphylos uva-ursi* (1-5%), *Arnica cordifolia* (1-5%), *Epilobium angustifolium* (<1-5%), *Fragaria virginiana* (1-3%) and *Potentilla diversifolia* (1-2%). Bryoid layer cover is generally <10% and epiphytes are scarce.

Stands are 100 to 200 years old and O4 is advanced to mature successionally. The open forest physiognomy and occurrence of *Pinus albicaulis* distinguish O4. Stands intergrading with O10 may occur at higher elevations but O10 has an understory dominated by heaths (*Phyllodoce* spp. and *Cassiope* spp.) and is usually more mesic.

Other Studies: O4 is also described in BNP and JNP (Corns and Achuff 1982). In eastern British Columbia, Lea (1984, whitebark pine-grouseberry-roundleaved alumroot) describes a similar type. In Alberta, Hettinger (1975, *Picea-Pinus albicaulis/Juniperus communis/Elymus*) has a similar type in JNP and several of the timberline types of Baig (1972) in the Rockies (*Abies-Pinus albicaulis-Picea/*

Table 43. Stands of the white spruce-western larch-Douglas fir/bunchberry (C45) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	HD 10 17	HD 10 18
TREE LAYER		
Larix occidentalis	03	04
Picea glauca	06	03
Pinus contorta	.5	01
Pseudotsuga menziesii	04	02
TALL SHRUB LAYER		
Betula papyrifera	02	--
Acer glabrum	04	--
Alnus crispa	.5	--
Amelanchier alnifolia	--	03
Cornus stolonifera	.5	--
Pseudotsuga menziesii	01	01
SHRUB LAYER		
Shepherdia canadensis	.5	.5
HERB-DWARF SHRUB LAYER		
Aralia nudicaulis	35	--
Arnica cordifolia	02	02
Cornus canadensis	12	07
Disporum trachycarpum	.5	.5
Fragaria virginiana	--	07
Linnaea borealis	.5	.5
Lonicera involucrata	.5	05
Mitella nuda	.5	.5
Rosa acicularis	.5	02
Rubus parviflorus	01	02
Smilacina racemosa	.5	.5
Spiraea lucida	.5	05
Thalictrum occidentale	10	05
Osmorhiza sp.	.5	02
BRYOID LAYER		
Hylocomium splendens	--	45
Pleurozium schreberi	20	50
Ptilium crista-castrensis	.5	05

Phyllodoce, *Pinus albicaulis- Picea-Abies/Juniperus communis*, *Pinus albicaulis-Abies/Salix vestita*, *Picea-Pinus albicaulis/Salix glauca*, and *Abies-Pinus albicaulis*) show strong similarity. Pfister *et al.* (1977) in Montana have a similar *Pinus albicaulis-Abies lasiocarpa* type.

O5: ***Pseudotsuga menziesii/Juniperus communis/Arctostaphylos uva-ursi***

(Douglas fir/juniper/bearberry)

Environment: O5 occurs on subxeric Montane (960-1810 m) sites in southern KNP on steep, southerly aspect slopes (Plate 18). Soils are rapidly drained Regosolics and Brunisolics on gullied colluvial landforms. These are among the warmest and driest sites in KNP.

Vegetation: The open tree layer (5-20%) (Table 45) is composed mostly of *Pseudotsuga menziesii* (5-20%) with small amounts of *Pinus contorta* (≤4%). The shrub layer (15-25%) is dominated by *Juniperus communis* (5-30%) with *Shepherdia canadensis* (<1-3%), *Pseudotsuga menziesii* (1-3%)

Table 44. Stands of the Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	HD	HD	HD	MF	MF	MF	SD	SD	SD	SD
	10	20	21	20	20	20	20	20	20	20
	44	56	12	50	61	77	38	39	68	77
TREE LAYER										
Abies lasiocarpa	02	--	--	--	02	11	--	04	02	05
Picea engelmannii	04	.5	--	05	13	10	05	10	--	05
Pinus albicaulis	03	.5	--	04	10	24	05	04	08	.5
SHRUB LAYER										
Abies lasiocarpa	.1	.5	03	--	.5	35	03	03	10	03
Juniperus communis	01	.5	05	05	--	04	02	--	02	--
Picea engelmannii	.5	--	--	04	06	.5	10	--	--	01
Pinus albicaulis	--	.5	01	03	03	--	02	01	20	--
Potentilla fruticosa	--	--	03	03	--	02	15	--	--	--
Rhododendron albiflorum	--	--	--	02	--	--	--	05	02	--
Salix glauca	--	--	02	.5	--	01	.5	--	--	--
Salix vestita	--	--	--	02	04	02	--	--	--	01
Shepherdia canadensis	01	.5	01	03	02	.5	--	--	.5	--
HERB-DWARF SHRUB LAYER										
Achillea millefolium	.5	03	02	01	01	.5	.5	.5	--	01
Allium cernuum	.5	--	.5	01	--	--	--	--	--	--
Anemone spp.	05	02	--	01	10	--	01	--	--	--
Antennaria spp.	.5	05	--	--	--	--	.5	--	.5	.5
Antennaria racemosa	20	01	.5	03	07	02	--	.5	--	--
Aquilegia flavescens	--	--	--	01	--	03	--	--	--	--
Arnica cordifolia	07	03	01	.5	02	01	--	05	03	--
Carex spp.	.5	--	--	02	--	--	--	02	--	--
Carex scirpoidea	--	--	--	--	04	--	08	--	03	--
Castilleja spp.	--	.5	--	01	03	--	.5	05	--	--
Dryas octopetala	--	--	.5	06	04	--	01	--	--	--
Epilobium angustifolium	02	--	05	--	.5	.5	--	.5	10	.5
Erigeron grandiflorus	--	--	--	--	--	--	--	10	02	.5
Fragaria virginiana	10	03	01	01	10	01	.5	.5	10	.5
Hedysarum sulphurescens	10	02	02	--	06	--	--	--	--	02
Pedicularis spp.	.5	--	--	.5	.5	01	--	.5	--	--
Poa spp.	35	05	01	--	--	--	.5	--	.5	.5
Potentilla diversifolia	03	02	.5	01	.5	--	--	01	--	--
Salix arctica	--	03	--	--	.5	--	03	--	--	--
Saxifraga bronchialis	01	--	20	--	--	--	--	--	--	.5
Senecio lugens	.5	01	02	--	--	--	--	--	--	01
Stenanthium occidentale	--	--	--	01	06	14	--	--	--	--
Vaccinium scoparium	--	--	--	20	13	--	--	05	05	--
Valeriana sitchensis	01	--	--	--	--	03	--	--	.5	--
Sedum lanceolatum	--	.5	.5	--	.5	--	.5	--	.5	--
BRYOID LAYER										
Brachythecium spp.	.5	--	.5	--	--	--	.5	02	.5	--
Dicranum spp.	--	--	--	03	--	--	.5	--	.5	--
Tortula spp.	.5	--	.5	--	.5	--	10	--	--	--
Cladonia spp.	.5	--	.5	02	05	--	.5	--	03	--
Peltigera rufescens	.5	--	.5	--	--	--	.5	01	--	--
EPIPHYTES										
Bryoria spp.	--	--	.5	--	--	.5	--	.5	--	--
Letharia vulpina	.5	--	--	--	--	.5	.5	.5	.5	--
Parmeliopsis ambigua	--	--	--	--	--	--	.5	.5	--	--

Table 45. Stands of the Douglas fir/juniper/bearberry (O5) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	HD 10 04	HD 10 29	HD 20 01	HD 20 18	HD 20 23	HD 20 58	JD 10 12	MF 20 33
TREE LAYER								
Betula papyrifera	--	01	--	02	--	--	--	--
Picea glauca	--	--	--	01	01	--	--	--
Pinus contorta	--	--	--	01	--	.5	04	02
Pinus flexilis	--	03	--	--	--	--	--	--
Pseudotsuga menziesii	20	06	05	06	01	.5	26	05
SHRUB LAYER								
Amelanchier alnifolia	--	--	--	05	--	--	--	04
Chrysothamnus nauseousus	03	--	--	--	--	--	--	--
Juniperus communis	--	15	08	30	--	05	60	03
Juniperus scopulorum	.5	--	15	10	--	--	--	--
Prunus virginiana	--	--	--	02	--	--	--	--
Pseudotsuga menziesii	03	--	--	.5	--	.5	09	01
Shepherdia canadensis	.5	02	02	.5	--	03	.5	07
HERB-DWARF SHURB LAYER								
Acer glabrum	--	.5	--	.5	--	--	--	02
Achillea millefolium	01	.5	03	.5	--	.5	--	01
Agropyron spicatum	.5	--	05	--	--	--	--	01
Amelanchier alnifolia	05	.5	.5	.5	.5	--	--	04
Anemone multifida	01	.5	.5	--	.5	.5	--	01
Apocynum androsaemifolium	--	--	--	03	.5	--	--	--
Arctostaphylos uva-ursi	20	05	08	20	01	15	02	04
Aster ciliolatus	03	--	--	02	--	--	--	02
Aster conspicuus	--	--	05	--	--	--	.5	--
Berberis repens	--	02	--	--	--	05	--	--
Calamagrostis rubescens	01	--	35	--	--	--	--	02
Fragaria virginiana	.5	.5	.5	.5	--	02	--	02
Linnaea borealis	--	03	--	04	--	--	--	04
Potentilla fruticosa	--	02	--	.5	--	03	.5	--
Rosa acicularis	--	--	02	05	--	--	.5	01
Spiraea lucida	.5	--	.5	03	--	--	.5	--
Viola adunca	--	--	--	.5	--	.5	--	01
Zygadenus elegans	--	02	--	--	.5	02	--	--
Solidago sp.	--	--	02	--	--	--	--	03
BRYOID LAYER								
Hypnum revolutum	--	--	.5	--	--	--	.5	--
Tortella tortuosa	--	02	--	.5	--	--	--	--
Tortula ruralis	.5	--	--	--	--	--	--	--
Cladonia fimbriata	--	.5	--	--	--	--	--	.5
Peltigera rufescens	--	--	--	--	--	--	.5	02
EPIPHYTES								
Hypogymnia physodes	.5	--	--	--	--	--	.5	--
Letharia vulpina	--	--	.5	--	--	.5	.5	--

and *Juniperus scopulorum* (10-15%) common. *Arctostaphylos uva-ursi* (5-20%) dominates the herb-dwarf shrub layer which generally has <35% cover. Frequent species with low cover include *Achillea millefolium*, *Agropyron spicatum*, *Amelanchier alnifolia*, *Anemone multifida*, *Calamagrostis rubescens*, *Fragaria virginiana* and *Spiraea lucida*. Bryoid layer cover is ≤2% and sporadic. Epiphytes are scarce.

Stands are 100 to 200 years old and O5 is mature successionally. O5 differs from C1 in having an open forest physiognomy and greater cover of *Arctostaphylos uva-ursi* and *Agropyron spicatum*. O24 is separated by the presence of *Pinus ponderosa*, although O24 and O5 have many similarities.

Other Studies: O5 is also described in BNP and JNP (Corns and Achuff 1982). In British Columbia, similar types are described by Kuchar (1978, Douglas fir/common juniper) in Yoho National Park and by Beil (1974, *Vaccinium scoparium/Arctostaphylos uva-ursi*) in southern British Columbia. In Alberta, Kuchar (1973) has a conifer savanna dominated by *Pseudotsuga menziesii* in Waterton Lakes National Park. Steele *et al.* (1983, *Pseudotsuga menziesii/Juniperus communis*) describe a similar type in northwestern Wyoming and adjacent Idaho and Montana, and also from central Idaho (Steele *et al.* 1981). Pfister *et al.* (1977) also describe a comparable type in Montana.

O6: *Picea engelmannii-Abies lasiocarpa/Salix* spp./*Aulacomnium palustre*

(Engelmann spruce-subalpine fir/willow/ribbed bog moss)

Environment: O6 occurs on hygric to subhydric Lower Subalpine (1280-1910 m) sites with gentle slopes. Soils are poorly to very poorly drained Gleysols and Organics on fluvial and morainal landforms, often with seepage.

Vegetation: *Picea engelmannii* (10-12%) dominates the open tree layer (≤15%) (Table 46). The shrub layer is usually dense (35-75%) with *Salix glauca* (5-35%), *Betula glandulosa* (<15%), and *Ledum groenlandicum* most important. The herb-dwarf shrub layer (40-70%) is diverse and dominated by *Carex* spp. (10-35%). Also important are *Equisetum* spp. (1-15%), *Fragaria virginiana* (1-3%), *Petasites vitifolius* (1-3%), *Pedicularis bracteosa* (<1%) and, on better drained hummocks, *Vaccinium scoparium*. *Aulacomnium palustre* (10-40%) and *Tomenthypnum nitens* (10-35%) dominate the bryoid layer.

O6 is successionally mature with stand ages 200 to >300 years. O6 is distinguished by its open tree layer and the dominance of *Salix* spp. in the shrub layer and *Aulacomnium palustre* in the herb-dwarf shrub layer.

Other Studies: O6 is also described in BNP and JNP (Corns and Achuff 1982). No similar types are described by other authors.

O9: *Picea engelmannii-Abies lasiocarpa/Valeriana sitchensis-Erigeron peregrinus*

(Engelmann spruce-subalpine fir/valerian-fleabane)

Environment: O9 occurs on mesic to subhygric Upper Subalpine sites (2010-2310 m) in northern KNP on various slopes and aspects. Soils are imperfectly to poorly drained Brunisolics and Gleysols on fluvial and morainal landforms often with seepage.

Vegetation: The tree layer is open (5-20%) (Table 47) and dominated by *Picea engelmannii* (5-20%) and *Abies lasiocarpa* (5-20%). The shrub layer is sparse (<15%) with *Abies lasiocarpa* and *Salix* spp. most common. The herb-dwarf shrub layer is species-rich and has a total cover of 50-90%. Dominant species are *Valeriana sitchensis*, *Erigeron peregrinus* (5-10%), *Trollius albiflorus* (3-10%), *Vaccinium scoparium* (3-15%) and *Pedicularis bracteosa* (1-3%). Important species include *Senecio triangularis*, *Anemone occidentalis*, *Antennaria lanata*, *Phyllodoce empetriformis*, *Fragaria virginiana* and *Veratrum eschscholtzii*. Bryoid layer cover is variable with *Dicranum scoparium* (5-15%), *Barbilophozia lycopodioides* (5-10%) and *Cladonia* spp. most common.

Stands of O9 are 100 to >300 years old and are mature successionally. O9 differs from O10 by being moister and dominated by herbs rather than dwarf shrubs in the herb-dwarf shrub layer. H16 has many species in common with O9 but lacks tree cover, although some intergrading stands occur.

Other Studies: O9 is also described in BNP and JNP (Corns and Achuff 1982) and in MRNP and GNP (Achuff and Dudynsky 1984). In British Columbia, Clement (1981) describes a similar alpine fir-bracted lousewort-broadleaved arnica-sitka valerian type near Vernon. Eady (1971) has an *Abies*

Table 46. Stands of the Engelmann spruce-subalpine fir/willow/ribbed bog moss (O6) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	AW 50 61	AW 70 23	AW 70 47	JD 80 05	KS 60 07	PA 70 29	PA 71 32	JD 20 02	SD 20 78	MF 21 03
TREE LAYER										
Picea engelmannii	06	24	10	15	15	10	02	10	12	15
Pinus contorta	--	.5	--	--	--	--	08	--	--	--
SHRUB LAYER										
Abies lasiocarpa	--	06	01	--	--	.5	--	--	14	02
Betula glandulosa	11	17	--	01	04	--	15	--	15	--
Juniperus communis	--	02	.5	--	--	.5	05	.5	--	--
Ledum groenlandicum	03	02	02	--	02	10	.5	.5	--	--
Lonicera involucrata	--	--	01	.5	--	10	--	--	--	--
Picea engelmannii	03	06	08	04	03	05	5	03	--	01
Potentilla fruticosa	09	02	01	--	01	01	10	01	10	--
Salix barrattiana	07	01	10	--	--	.5	10	--	02	--
Salix farrae	02	--	--	--	30	15	--	--	--	15
Salix glauca	--	--	--	75	30	--	--	35	10	--
Salix vestita	02	01	01	--	--	--	05	--	05	05
Salix spp.	--	04	35	--	--	--	--	--	--	60
HERB-DWARF SHRUB LAYER										
Anemone parviflora	.5	.5	01	--	--	--	--	--	--	02
Aster ciliolatus	--	--	--	10	--	.5	--	.5	--	--
Carex aquatilis	03	--	18	--	10	--	--	--	--	--
Carex rostrata	--	--	--	--	40	--	--	--	--	--
Carex scirpoidea	30	--	--	--	--	--	40	--	15	--
Carex vaginata	15	07	02	--	--	--	--	--	--	--
Carex spp.	01	.5	.5	65	08	10	--	35	--	--
Cornus canadensis	--	01	02	--	--	--	--	.5	--	--
Epilobium angustifolium	--	--	.5	10	--	01	--	--	--	--
Erigeron peregrinus	04	--	--	--	--	--	01	--	03	08
Fragaria virginiana	--	--	02	15	--	02	--	01	03	07
Juncus spp.	--	--	02	--	--	--	--	.5	--	--
Kalmia polifolia	03	--	--	--	--	01	03	--	03	--
Mitella nuda	--	--	01	02	02	--	--	--	.5	--
Parnassia fimbriata	.5	--	--	--	--	.5	--	--	02	02
Pedicularis bracteosa	.5	.5	--	--	--	.5	.5	--	--	02
Pedicularis groenlandica	--	--	01	--	--	--	.5	--	--	--
Petasites vitifolius	--	--	--	03	01	01	--	--	.5	--
Polygonum viviparum	02	.5	--	--	--	.5	.5	--	.5	--
Rubus acaulis	--	--	--	02	15	.5	--	.5	--	--
Senecio lugens	.5	--	--	--	--	.5	--	.5	02	--
Trollius albiflorus	02	--	--	--	--	.5	--	--	05	05
Vaccinium scoparium	--	12	02	.5	--	--	.5	--	03	--
Equisetum arvense	.5	01	01	15	10	--	--	--	--	08
Equisetum scirpoides	--	.5	01	02	--	01	--	01	--	--
Equisetum variegatum	.5	--	.5	--	--	.5	--	--	--	08
BRYOID LAYER										
Aulacomnium palustre	.5	04	03	35	40	40	10	30	--	35
Cladonia ecmocyna	--	.5	--	.5	--	.5	--	--	.5	--
Dicranum spp.	20	02	--	02	--	--	10	--	--	.5
Drepanocladus revolvens	08	--	20	--	--	--	--	01	--	--

Table 47. Stands of the Engelmann spruce-subalpine fir/valerian-fleabane (O9) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	AW	IC	JM	PA	PA	SJ	HD
	60	90	70	90	90	91	21
	93	55	81	78	88	00	34
TREE LAYER							
Abies lasiocarpa	23	14	.5	10	05	06	07
Picea engelmannii	27	01	07	05	10	08	01
TALL SHRUB LAYER							
Abies lasiocarpa	02	05	03	.5	.5	--	.5
Picea engelmannii	.5	--	--	--	.5	.5	--
SHRUB LAYER							
Abies lasiocarpa	14	05	01	.5	--	05	05
Picea engelmannii	--	--	--	--	.5	02	--
Salix spp.	--	.5	07	--	10	02	.5
HERB-DWARF SHRUB LAYER							
Abies lasiocarpa	--	18	--	.5	.5	--	.5
Anemone occidentalis	--	05	02	30	.5	--	--
Antennaria lanata	--	01	02	03	--	--	--
Arnica cordifolia	.5	--	--	--	03	01	--
Arnica latifolia	--	--	02	--	--	--	03
Artemisia norvegica	--	--	02	10	35	--	--
Cassiope mertensiana	.5	--	50	--	--	--	--
Deschampsia atropurpurea	--	--	03	--	--	--	.5
Epilobium angustifolium	--	01	--	.5	.5	--	--
Erigeron peregrinus	.5	02	05	05	05	05	.5
Fragaria virginiana	--	.5	--	--	03	05	.5
Mitella nuda	.5	--	--	--	--	--	01
Parnassia spp.	.5	--	--	--	--	01	.5
Pedicularis bracteosa	01	03	03	02	15	01	02
Phyllodoce empetriformis	.5	--	10	--	05	.5	01
Polygonum viviparum	.5	.5	--	--	.5	.5	--
Pyrola asarifolia	--	--	--	--	.5	01	--
Ranunculus spp.	.5	01	--	.5	--	--	--
Senecio triangularis	.5	--	--	01	--	--	01
Thalictrum occidentale	.5	--	--	--	--	03	.5
Trollius albiflorus	.5	--	--	25	--	--	03
Vaccinium membranaceum	.5	--	.5	--	--	03	01
Vaccinium scoparium	02	--	07	--	--	--	03
Valeriana sitchensis	.5	03	07	10	--	03	02
Veratrum eschscholtzii	01	--	--	05	--	02	--
BRYOID LAYER							
Barbilophozia lycopodioides	18	--	04	--	05	02	--
Brachythecium spp.	20	.5	--	05	--	--	--
Cladonia spp.	02	.5	.5	02	03	.5	--
Dicranum scoparium	--	--	05	--	05	--	--
Eurhynchium pulchellum	--	.5	--	--	01	--	--
Peltigera spp.	--	.5	--	03	02	--	--
Tortula norvegica	--	.5	--	05	01	--	--

lasiocarpa-Valeriana sitchensis type in central British Columbia, and Lea (1984) has a similar type (alpine fir-subalpine fleabane-Sitka valerian) in the East Kootenays. In Alberta, similar types are described by Trottier and Scotter (1973, *Picea-Abies/Trollius albiflorus/Carex* spp.) in BNP and by Baig (1972, *Pinus albicaulis-Abies-Picea/Valeriana sitchensis*) in the southern Rockies. Habeck (1969) has a similar type at Logan Pass, Glacier National Park, Montana.

O10: ***Picea engelmannii-Abies lasiocarpa/Phyllodoce glanduliflora-Cassiope mertensiana***

(Engelmann spruce-subalpine fir/heather)

Environment: O10 occurs on mesic Upper Subalpine (2160-2340 m) sites throughout the park on moderate to steep slopes of predominantly northerly aspects. Soils are well drained Eutric and Dystric Brunisols and Orthic Humo-Ferric Podzols on morainal and colluvial landforms.

Table 48. Stands of the Engelmann spruce-subalpine fir/heather (O10) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	HD	HD	HD	SD
	20	20	20	20
	55	60	79	34
TREE LAYER				
Abies lasiocarpa	.5	10	05	--
Larix lyallii	05	--	--	02
Picea engelmannii	03	01	03	18
SHRUB LAYER				
Abies lasiocarpa	--	03	.5	--
Larix lyallii	.5	--	--	--
Picea engelmannii	--	--	.5	05
Rhododendron albiflorum	--	01	.5	--
HERB-DWARF SHRUB LAYER				
Abies lasiocarpa	.5	.5	.5	--
Achillea millefolium	.5	--	--	.5
Antennaria lanata	02	--	--	.5
Arnica cordifolia	05	--	--	.5
Cassiope mertensiana	--	--	10	--
Dryas octopetala	03	--	--	02
Epilobium angustifolium	.5	--	--	.5
Fragaria virginiana	02	--	--	.5
Mitella nuda	--	.5	02	--
Pedicularis bracteosa	05	05	01	--
Phyllodoce empetriformis	--	--	08	--
Phyllodoce glanduliflora	20	03	--	20
Poa alpina	03	--	--	--
Ranunculus eschscholtzii	01	01	.5	.5
Sibbaldia procumbens	.5	--	--	.5
Stenanthium occidentale	--	01	--	03
Trollius albiflorus	10	--	05	--
Vaccinium scoparium	35	08	05	40
Veratrum eschscholtzii	05	.5	.5	--
Viola orbiculata	.5	02	.5	--
BRYOID LAYER				
Brachythecium groenlandicum	.5	--	--	.5
Dicranum scoparium	--	01	10	--
Polytrichum juniperinum	.5	02	01	02
Tortula ruralis	--	--	--	05
Barbilophozia lycopodioides	.5	--	.5	--
Peltigera aphthosa	03	03	--	--

Vegetation: *Picea engelmannii* (5-20%) and *Abies lasiocarpa* (3-20%) dominate the open tree layer (Table 48). The shrub layer is dominated by *Abies lasiocarpa* regeneration. The herb-dwarf shrub layer has 30 to 85% cover due largely to *Cassiope mertensiana* (10-50%), *Phyllodoce glanduliflora*

(5-30%) and *Vaccinium scoparium* (5-25%). Other common species include *Arnica latifolia* (1-5%), *Antennaria lanata* (2-10%) and *Pedicularis bracteosa* (1-5%). Cover of the bryoid layer is variable (5-75%) with *Dicranum scoparium, Polytrichum juniperinum, Barbilophozia lycopodioides* and *Peltigera aphthosa* most common. Epiphytes are sparse with *Letharia vulpina* most frequent.

O10 is successionally mature with stands 200 to 400 years. O10 is distinguished from C34 by its open physiognomy and occurring at slightly higher elevations. O10 is drier than O9 and the herb-dwarf shrub layer is dominated by dwarf shrubs such as *Cassiope mertensiana* and *Phyllodoce glanduliflora* rather than herbs such as *Valeriana sitchensis* and *Erigeron peregrinus*. Stands with abundant *Larix lyallii* may intergrade with O13. Stands with very low tree cover intergrade with L5.

Other Studies: O10 is also described in BNP and JNP (Corns and Achuff 1982) and in MRNP and GNP (Achuff and Dudynsky 1984). In British Columbia, Kuchar (1978, alpine fir forest, in part) describes a similar type from Yoho National Park, McLean (1970) has an *Abies lasiocarpa-Vaccinium scoparium* type, Eady (1971) has an *Abies lasiocarpa-Picea engelmannii-Vaccinium scoparium* type, and Lea (1984) has an alpine fir-grouseberry-cream mountain heather type. In Alberta, similar types are described by La Roi (1975, *Picea engelmannii/Phyllodoce* types) and Beil (1966) in JNP, by Baig (1972, *Abies-Picea/Phyllodoce*), by Kirby and Ogilvie (1969, krummholz/*Vaccinium scoparium*), by Ogilvie (1976, *Phyllodoce-Vaccinium scoparium*), and by Johnson (1975, *Picea engelmannii-Vaccinium scoparium*).

O11: *Picea* spp./*Ledum groenlandicum/Tomenthypnum nitens*

(spruce/Labrador tea/brown moss)

Environment: O11 occurs on hygric to subhygric Montane (1070-1450 m) sites in the Vermilion Valley. Slopes are nearly level and aspects various. Soils are imperfectly to poorly drained Gleysolics and Regosolics on fluvial and glacial landforms.

Vegetation: The tree layer is open (5-15%) (Table 49) and dominated by *Picea glauca* (5-10%). The shrub layer (20-50%) is composed mostly of *Ledum groenlandicum* (10-20%) and *Betula glandulosa* (3-15%) with lesser amounts of *Juniperus communis* (1-10%), *Potentilla fruticosa* (3-5%) and *Salix glauca* (1-5%). The herb-dwarf shrub layer is dense (35-80%) and species-rich. Common are *Carex* spp. (3-10%), *Equisetum* spp. (1-5%), *Cornus canadensis* (1-3%), *Linnaea borealis* (1-5%) and *Mitella nuda* (<1-4%). Species with low cover but high frequency include *Fragaria virginiana, Habenaria dilatata, Oxycoccus microcarpus, Rosa acicularis* and *Rubus pubescens*. *Tomenthypnum nitens* (5-10%), *Aulacomnium palustre* (3-5%) and *Pleurozium schreberi* (1-3%) are most common in the bryoid layer.

O11 stands are 100 to 275 years old and mature successionally. *Picea* spp. regeneration occurs in nearly all stands. O11 is distinguished from O6 by having *Ledum groenlandicum* dominant in the shrub layer rather than *Salix* spp. and by occurring in the Montane rather than the Subalpine.

Other Studies: O11 is also described in BNP and JNP (Corns and Achuff 1982) and in MRNP and GNP (Achuff and Dudynsky 1984). No similar types are described by other authors in British Columbia. In Alberta, La Roi (1975, *Picea mariana/Ledum groenlandicum/Equisetum arvense-Carex* spp.) and Laidlaw (1971, *Picea mariana/- Tomenthypnum*) both in JNP, Jacques and Legge (1974, *Picea/Sphagnum-Ledum*) in the Kananaskis area, and Ogilvie (1963, Kirby and Ogilvie 1969; *Picea/Sphagnum-Ledum*) describe similar types. Raup (1947) describes a similar muskeg forest for the southwestern Northwest Territories.

O13: *Larix lyallii-Abies lasiocarpa/Cassiope mertensiana*

(subalpine larch-subalpine fir/heather)

Environment: O13 occurs on mesic to subhygric Upper Subalpine (2020-2390 m) sites in the northern half of KNP on moderate to gentle slopes with southerly to westerly aspects (Plate 43). Soils are mostly well to imperfectly drained Eutric and Dystric Brunisols. Lithic or turbic phases are common. Landforms are colluvial and morainal often with eolian veneers or solifluction.

Table 49. Stands of the spruce/Labrador tea/brown moss (Ol1) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	BB	HD	MF	MF	AW	PA
	10	20	20	21	71	70
	26	19	35	47	03	17
TREE LAYER						
Picea glauca	--	12	10	07	07	07
Pinus contorta	10	01	--	02	--	.5
SHRUB LAYER						
Betula glandulosa	02	--	37	--	25	10
Juniperus communis	30	.5	01	11	--	--
Ledum groenlandicum	05	15	35	18	05	07
Picea glauca	--	05	10	09	06	02
Pinus contorta	06	--	--	03	--	--
Potentilla fruticosa	--	--	10	03	05	03
Salix glauca	.5	--	.5	05	--	--
HERB-DWARF SHRUB LAYER						
Antennaria pulcherrima	--	--	--	06	--	--
Aster ciliolatus	--	02	--	01	--	--
Calypso bulbosa	--	03	--	--	--	--
Carex aquatilis	--	--	.5	--	25	10
Carex spp.	01	--	10	06	--	01
Carex scirpoidea	--	--	--	24	10	--
Cornus canadensis	.5	03	01	.5	--	--
Elymus innovatus	--	35	--	--	--	--
Empetrum nigrum	15	--	--	03	--	02
Fragaria virginiana	--	02	--	.5	--	--
Galium boreale	.5	.5	--	--	--	--
Habenaria dilatata	01	--	--	.2	--	--
Linnaea borealis	01	05	04	02	--	--
Mitella nuda	.5	.5	04	01	--	--
Oxycoccus microcarpus	01	--	02	02	--	02
Petasites palmatus	02	--	--	02	--	--
Pinus contorta	--	.5	--	05	--	--
Rosa acicularis	--	01	03	01	--	--
Rubus pubescens	--	01	.5	--	--	--
Vaccinium vitis-idaea	.5	--	.5	--	01	03
Equisetum spp.	05	--	02	--	--	03
BRYOID LAYER						
Aulacomnium palustre	05	--	.5	03	03	03
Hylocomium splendens	--	75	--	26	--	15
Pleurozium schreberi	01	.5	03	01	--	--
Sphagnum fuscum	70	--	25	--	--	--
Sphagnum warnstorfii	--	--	--	08	--	10
Tomenthypnum nitens	10	--	01	05	44	70
Cladonia ecmocyna	.5	--	--	02	--	--
Peltigera aphthosa	01	.5	--	02	02	--
Peltigera polydactyla	--	--	01	.5	--	--
EPIPHYTES						
Alectoria sarmentosa ssp. sarmentosa	.5	--	--	.5	--	--
Cetraria pinastri	.5	--	--	.5	--	--
Letharia vulpina	.5	--	--	.5	--	--

Vegetation: The open tree layer (Table 50) is characterized by *Larix lyallii* (3-10%) and *Abies lasiocarpa* (3-5%). The shrub layer is usually sparse (3-25%) and dominated by *Abies lasiocarpa* (2-10%) and *Larix lyallii* (2-5%). Total cover of the herb-dwarf shrub layer is 20 to 80% with *Cassiope mertensiana* (5-19%), *Phyllodoce* spp. (2-10%) and *Vaccinium scoparium* (5-20%) most common. Common species with low cover include *Anemone occidentalis, Antennaria lanata, Arnica cordifolia, Claytonia lanceolata, Epilobium angustifolium, Pedicularis bracteosa, Potentilla diversifolia* and *Sibbaldia procumbens*. Bryoid layer cover is variable with *Dicranum scoparium, Pohlia nutans, Tortula ruralis, Barbilophozia hatcheri* and *Cladonia ecmocyna* most common. Epiphytes are sparse with *Letharia vulpina* most frequent.

O13 is successionally mature with stand ages of 140 to 260 years. O13 differs from C23 primarily in its open forest physiognomy. Both are distinguished by the dominance of *Larix lyallii*.

Other Studies: O13 is very similar to C23 and most authors have not split *Larix lyallii* forest on a physiognomic basis as done in KNP. Thus, the *Other Studies* for C23 are also cited here for O13. C23 is described in BNP and JNP (Corns and Achuff 1978) and some BNP and JNP C23 stands better fit O13. In British Columbia, Kuchar (1978) describes alpine larch forest in Yoho National Park. In Alberta, similar types are described by Trottier and Scotter (1973, *Abies-Picea-Larix/Vaccinium scoparium/Phyllodoce* spp.-*Cassiope mertensiana, Larix/Vaccinium scoparium/Trollius albiflorus/Carex nigricans, Abies-Picea-Larix/Phyllodoce* spp./*Vaccinium scoparium/Carex nigricans*) in BNP, by Baig (1972) for the southern Rocky Mountains, by Jacques and Legge (1974, spruce-fir-alpine larch/grouseberry) in the Kananaskis area, by Ogilvie (1976, *Picea-Abies-Larix/Luzula wahlenbergii*), and by Kuchar (1973, fir/alpine larch) for Waterton Lakes National Park.

In Montana, Pfister *et al.* (1977) describe alpine larch forest and vegetation described by Arno and Habeck (1972) in the Pacific Northwest of the United States, especially in western Montana, appears quite similar to O13 although no types were recognized *per se*.

O14: *Picea engelmannii-Abies lasiocarpa/Salix vestita/Pedicularis bracteosa*

(Engelmann spruce-subalpine fir/rock willow/bracted lousewort)

Environment: O14 occurs on subhygric to hygric Subalpine (1790-2080 m) sites in the northern part of KNP on moderate slopes of various aspect. Soils are imperfectly to poorly drained Gleysolics and gleyed Regosolics on fluvial and morainal landforms.

Vegetation: *Picea engelmannii* (5-15%) dominates the tree layer (Table 51, Plate 14) with lesser amounts of *Abies lasiocarpa* (2-5%). The shrub layer (10-70%) is dominated by *Salix vestita* (5-45%) with *Abies lasiocarpa* (2-5%) also important. The herb-dwarf shrub layer is generally lush (30-60%) with *Pedicularis bracteosa* (1-5%) and *Erigeron peregrinus* (2-4%) most important. Other species with low cover but high frequency include *Anemone parviflora, Carex scirpoidea, Fragaria virginiana, Polygonum viviparum, Trollius albiflorus* and *Vaccinium scoparium*. Bryoid layer cover is variable (15-90%) with *Barbilophozia hatcheri, Dicranum scoparium, Drepanocladus uncinatus* and *Cladonia ecmocyna* most common.

Stand ages of 200 to 400 years indicate that O14 is successionally mature. O14 is characterized by the dominance of *Salix vestita* in the shrub layer.

Other Studies: O14 is also described in BNP and JNP (Corns and Achuff 1982). No similar types are described in British Columbia. In Alberta, similar types are described by Baig (1972, *Abies-Picea/Salix vestita*) in the Rocky Mountains and by Kondla (1978, spruce/willow) in the Kananaskis area.

O24: *Pseudotsuga menziesii-Pinus ponderosa/Agropyron spicatum*

(Douglas fir-ponderosa pine/bluebunch wheatgrass)

Environment: O24 is limited to the Stoddart Creek area of southern KNP (Plate 19). It occurs on subxeric to xeric Montane (920-1050 m) sites with steep, southerly and westerly aspects. Soils are rapidly drained Regosolics on colluvial and morainal landforms.

Table 50. Stands of the subalpine larch-subalpine fir/heather (O13) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	HD	HD	HD	MF	MF	MF	PA	SD	SD	SD
	20	20	21	20	20	21	20	20	20	21
	70	87	35	94	98	07	28	55	69	36
TREE LAYER										
Abies lasiocarpa	03	02	06	01	06	18	01	05	05	--
Larix lyallii	08	08	02	10	04	07	03	05	10	04
Picea engelmannii	--	--	01	--	--	--	04	--	--	--
Pinus albicaulis	--	--	.5	--	--	--	03	--	--	--
SHRUB LAYER										
Abies lasiocarpa	--	--	04	--	04	08	02	50	15	01
Larix lyallii	.5	03	--	01	03	--	--	20	05	02
Rhododendron albiflorum	--	--	--	--	--	--	02	--	10	--
HERB-DWARF SHRUB LAYER										
Abies lasiocarpa	--	.5	--	--	.5	02	.5	.5	--	01
Achillea millefolium	.5	--	02	--	--	--	.5	--	--	.5
Anemone occidentalis	--	--	--	18	05	--	--	--	--	05
Antennaria lanata	02	--	--	03	--	--	--	--	--	10
Arnica cordifolia	--	--	--	02	03	07	--	02	.5	--
Arnica latifolia	20	--	--	--	--	--	.5	.5	--	--
Cassiope mertensiana	--	10	--	04	10	05	--	--	05	--
Claytonia lanceolata	01	--	--	01	02	--	--	--	--	--
Epilobium angustifolium	.5	--	.5	--	--	.5	--	.5	02	--
Erigeron peregrinus	--	--	--	--	04	01	03	--	--	05
Fragaria virginiana	--	--	.5	--	--	02	01	01	03	--
Juncus drummondii	--	--	--	01	.5	--	--	--	--	--
Larix lyallii	--	03	--	--	.5	--	--	--	--	.5
Parnassia fimbriata	--	--	--	--	16	--	--	--	02	--
Pedicularis bracteosa	--	--	--	--	.5	02	--	--	.5	--
Phyllodoce empetriformis	--	10	--	07	--	05	.5	.5	.5	--
Phyllodoce glanduliflora	.5	--	--	08	--	02	--	--	--	--
Potentilla diversifolia	.5	--	.5	--	--	--	.5	--	--	.5
Potentilla fruticosa	--	--	03	--	--	--	.5	--	--	--
Ranunculus eschscholtzii	.5	--	--	03	05	02	--	--	--	--
Saxifraga lyallii	--	--	--	.5	.5	.5	--	--	.5	--
Senecio triangularis	01	--	--	02	01	--	--	.5	--	10
Sibbaldia procumbens	.5	--	.5	--	02	.5	.5	--	.5	03
Stenanthium occidentale	--	--	--	--	--	04	--	.5	--	--
Trisetum spicatum	--	--	.5	--	--	--	.5	--	--	.5
Vaccinium membranaceum	--	--	.5	--	--	--	.5	--	.5	--
Vaccinium scoparium	35	05	08	04	02	05	20	05	03	20
Valeriana sitchensis	--	--	02	30	10	10	01	.5	.5	10
Viola orbiculata	.5	--	.5	--	--	08	--	--	--	--
BRYOID LAYER										
Dicranum spp.	--	30	.5	--	--	.5	--	03	--	--
Pohlia nutans	--	--	.5	--	--	.5	--	.5	--	.5
Rhacomitrium canescens	05	--	25	--	--	--	--	--	--	.5
Tortula spp.	--	--	.5	--	03	--	--	02	04	01
Barbilophozia lycopodioides	--	--	--	--	--	13	--	10	--	--
Cladonia ecmocyna	--	--	01	--	--	01	--	.5	--	02
Peltigera aphthosa	--	--	02	--	--	--	--	.5	03	--
Peltigera rufescens	05	--	02	--	--	--	--	--	--	.5
EPIPHYTES										
Letharia vulpina	--	.5	.5	.5	--	.5	--	--	--	--

Table 51. Stands of the Engelmann spruce-subalpine fir/rock willow/bracted lousewort (O14) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	HD	HD	MF	MF	SD
	10	20	21	21	20
	22	84	01	42	74
TREE LAYER					
Abies lasiocarpa	.5	03	--	03	10
Picea engelmannii	15	05	10	13	10
SHRUB LAYER					
Abies lasiocarpa	02	05	--	05	10
Picea engelmannii	01	--	05	04	--
Potentilla fruticosa	--	02	10	05	--
Rhododendron albiflorum	--	--	05	--	.5
Salix vestita	45	04	15	05	10
HERB-DWARF SHRUB LAYER					
Anemone parviflora	--	.5	08	.5	.5
Arnica latifolia	--	.5	07	--	--
Carex albo-nigra	--	--	01	.5	--
Carex scirpoidea	.5	.5	01	19	.5
Erigeron peregrinus	--	08	04	02	03
Fragaria virginiana	--	03	02	01	02
Kalmia polifolia	--	--	01	01	--
Parnassia fimbriata	--	--	09	--	.5
Pedicularis bracteosa	03	.5	01	02	.5
Petasites vitifolius	--	.5	01	--	--
Polygonum viviparum	--	01	.5	.5	02
Senecio triangularis	--	.5	02	--	02
Stenanthium occidentale	--	.5	03	01	01
Thalictrum occidentale	--	05	--	01	05
Trollius albiflorus	--	15	05	02	05
Vaccinium membranaceum	--	02	--	--	.5
Vaccinium scoparium	--	10	03	02	02
Equisetum variegatum	--	.5	01	01	--
BRYOID LAYER					
Bryum pseudotriquetrum	--	05	.5	.5	--
Campylium stellatum	--	10	.5	.5	--
Dicranum scoparium	.5	45	--	.5	02
Ditrichum flexicaule	90	05	--	.5	--
Drepanocladus uncinatus	.5	--	23	.5	--
Barbilophozia lycopodioides	.5	03	--	.5	03
Cladonia ecmocyna	--	02	02	02	01
EPIPHYTES					
Letharia vulpina	--	.5	--	--	.5
Parmeliopsis ambigua	--	.5	--	--	.5

Vegetation: The open tree layer (Table 52) is composed of *Pinus ponderosa* (2%) and *Pseudotsuga menziesii* (≤1%). A shrub layer is virtually absent. The herb-dwarf shrub layer is sparse (20-40%) with *Agropyron spicatum* (15-20%), *Apocynum androsaemifolium* (15-20%), *Chrysothamnus nauseosus* (2-3%) and *Amelanchier alnifolia* (≤1%) as characteristic species. Bryoids are scarce and bare mineral soil and rock comprise 50 to 60% of the ground surface.

O24 is successionally mature and distinguished by the occurrence of *Pinus ponderosa*. The area occupied by O24 and *Pinus ponderosa* is very limited. Stoddart Creek appears to be the northernmost occurrence of *Pinus ponderosa* in the Columbia Valley and *Pinus ponderosa* occurs in no other national park.

Table 52. Stands of the Douglas fir-ponderosa pine/wheatgrass (O24) v.t. Values are percent cover except for epiphytes where 0.5 indicates the species was present.

	HD	PA
	10	10
	04	00
	.1	.3
TREE LAYER		
Pinus ponderosa	02	02
Pseudostuga menziesii	.5	01
HERB-DWARF SHRUB LAYER		
Agropyron spicatum	15	20
Agropyron sp.	10	--
Allium cernuum	.5	--
Amelanchier alnifolia	.5	01
Apocynum androsaemifolium	20	15
Artemisia cana	.5	.5
Chicorium intybus	--	.5
Chrysopsis villosa	--	.5
Chrysothamnus nauseosus	02	03
Linum lewisii	.5	.5
Oryzopsis hymenoides	01	.5
Rosa woodsii	--	.5
Solidago sp.	.5	--
Symphoricarpos occidentalis	.5	02

Other Studies: Vegetation types similar to O24 occur primarily south of the U.S. border and O24 in KNP is at the northern extremity of its range. In British Columbia, Clement (1981) near Vernon has a similar ponderosa pine-common snowberry-beardless bluebunch wheatgrass type and Lea (1984) describes a similar Ponderosa pine-Rocky Mountain juniper-bluebunch wheatgrass-prairie koeleria type in the East Kootenays. In Montana, similar types are described by Tesch (1981) and Pfister *et al.* (1977, *Pseudotsuga menziesii/Agropyron spicatum*, *Pinus ponderosa/Agropyron spicatum*). In the eastern Cascades of Washington, del Moral and Fleming (1981) have a similar *Pinus ponderosa-Pseudotsuga menziesii/Agropyron spicatum-Carex geyeri* type.

SHRUB VEGETATION TYPES

S1: *Betula* spp.-*Potentilla fruticosa-Salix glauca/Tomenthypnum nitens*

(dwarf birch-shrubby cinquefoil-willow/brown moss)

Environment: S1 occurs on subhygric to hydric Montane (1140-1300 m) sites in the Kootenay and Vermilion valleys on level to gentle slopes of various aspect (Plate 55). Soils are poorly to very poorly drained Gleysolics and Terric Mesisols on fluvial landforms.

Vegetation: *Betula glandulosa* or *Betula pumila* (25-50%) dominate the shrub layer (50-85%) (Table 53). *Salix* spp. (5-30%) and *Potentilla fruticosa* (1-10%) are also characteristic. The herb-dwarf shrub layer has high cover (30-85%) but composition is variable with common species being *Carex aquatilis* (10-50%), other *Carex* spp. (5-20%), *Pyrola asarifolia* (<1%) and *Ledum groenlandicum* (<4%). The bryoid layer also has high cover with *Aulacomnium palustre* (30-75%) and *Tomenthypnum nitens* (15-55%) dominant.

S1 is successionally mature, maintained by a high water table and periodic inundation. S1 differs from S4 in occurring at lower elevations, in wetter sites, and with lower cover of *Salix barrattiana*.

Table 53. Stands of the dwarf birch-shrubby cinquefoil-willow/brown moss (S1) v.t. Values are percent cover.

	BB	HD	HD	JD	MF	PA	PA
	10	20	20	10	21	10	20
	03	17	30	11	37	80	13
SHRUB LAYER							
Betula spp.	50	55	25	80	05	35	55
Ledum groenlandicum	--	--	15	--	05	.5	--
Picea glauca	03	--	08	.5	05	02	--
Potentilla fruticosa	01	--	--	10	03	10	20
Salix barclayi	--	--	--	.5	--	30	--
Salix candida	--	--	--	--	02	--	--
Salix farrae	--	07	--	10	12	--	--
Salix glauca	--	--	--	--	03	--	--
Salix myrtillifolia	--	--	--	05	--	--	--
HERB-DWARF SHRUB LAYER							
Achillea millefolium	--	--	--	--	--	01	.5
Antennaria pulcherrima	--	--	--	--	06	--	.5
Arctostaphylos uva-ursi	--	--	--	--	05	02	05
Aster ciliolatus	--	--	--	.5	03	.5	.5
Calamagrostis inexpansa	--	10	.5	--	.5	--	--
Carex aquatilis	40	80	--	50	04	--	10
Carex rostrata	40	--	10	--	04	--	--
Cornus canadensis	--	--	--	--	02	.5	--
Fragaria virginiana	--	--	--	--	.5	02	01
Galium boreale	.5	--	--	--	03	01	.5
Linnaea borealis	--	--	--	--	01	--	10
Lonicera involucrata	.5	--	--	--	.5	--	--
Pyrola asarifolia	--	--	.5	--	.5	.5	.5
Rosa acicularis	--	--	--	--	.5	02	--
Rubus acaulis	01	.5	--	--	--	--	.5
Equisetum arvense	--	--	--	--	03	.5	--
BRYOID LAYER							
Aulacomnium palustre	.5	--	.5	75	.5	--	30
Drepanocladus revolvens	--	--	--	.5	08	--	--
Pleurozium schreberi	--	--	05	--	02	--	--
Tomenthypnum nitens	--	--	--	15	03	40	35
Peltigera aphthosa	--	--	.5	--	.5	--	05
Peltigera rufescens	--	--	--	--	.5	15	--

Betula glandulosa is also important in S16, but S16 is much drier and occurs on steeper slopes at higher elevations.

Other Studies: S1 is also described in BNP and JNP (Corns and Achuff 1982). In British Columbia, Kuchar (1978, dwarf shrub birch meadow) has a similar type in Yoho National Park. In Alberta, similar types are described by Jeffrey *et al.* (1968, *Salix-Potentilla-Betula*) and by Kondla (1978, birch-willow wetland) in Kananaskis Provincial Park.

S2: *Abies lasiocarpa-Salix* spp./*Valeriana sitchensis*

(subalpine fir-willow)

Environment: S2 occurs in northern KNP in the Lower to Upper Subalpine (1890-2160 m) on moderate to steep slopes of various aspect. Nearly all of the sites are snow avalanched and trees are stunted. Soils are well drained Orthic Regosols, Orthic Dystric Brunisols and Cumulic Humic Regosols on colluvial and morainal landforms.

Table 54. Stands of the subalpine fir-willow (S2) v.t. Values are percent cover.

	HD	HD	HD	HD	MF	MF	SD	SD	SD
	10	10	20	20	20	20	20	20	20
	06	34	47	61	83	96	47	62	87
	SHRUB LAYER								
Abies lasiocarpa	--	60	33	95	23	17	05	10	51
Betula glandulosa	--	--	10	--	35	--	--	--	--
Lonicera involucrata	--	.5	.5	--	.5	--	--	.5	10
Picea engelmannii	28	.5	06	--	05	--	05	--	01
Salix brachycarpa	--	--	--	--	--	--	10	--	--
Salix drummondiana	--	--	05	--	--	--	10	10	--
Salix glauca	--	--	--	--	.5	10	--	05	.5
Salix vestita	27	--	25	.5	.5	--	10	--	30
	HERB-DWARF SHRUB LAYER								
Anemone occidentalis	--	--	--	--	--	06	--	10	--
Antennaria racemosa	--	10	--	--	--	.5	--	--	--
Aquilegia flavescens	--	01	--	--	--	--	01	.5	--
Arnica cordifolia	.5	05	--	02	.5	05	01	--	02
Epilobium angustifolium	01	03	--	--	02	03	--	.5	.5
Fragaria virginiana	05	05	.5	.5	--	01	03	.5	.5
Heracleum lanatum	01	--	--	--	--	01	--	05	--
Linnaea borealis	--	--	02	--	03	--	--	--	--
Mitella nuda	--	--	--	.5	--	--	--	05	--
Parnassia fimbriata	--	--	--	--	--	07	--	.5	.5
Pedicularis bracteosa	01	02	.5	--	--	04	02	.5	--
Pyrola secunda	.5	.5	.5	--	--	.5	--	--	--
Ranunculus eschscholtzii	--	--	--	--	--	01	--	.5	--
Senecio triangularis	.5	--	--	--	--	04	--	15	--
Stenanthium occidentale	03	.5	--	--	--	.5	--	.5	--
Thalictrum occidentale	--	03	03	.5	.5	08	02	--	--
Vaccinium scoparium	--	--	02	01	11	10	--	.5	.5
Valeriana sitchensis	--	02	--	.5	--	15	.5	20	01
Veratrum eschscholtzii	--	--	01	--	--	04	--	.5	--
Viola orbiculata	.5	.5	--	.5	--	--	--	--	--
	BRYOID LAYER								
Brachythecium groenlandicum	--	--	--	--	--	--	02	--	--
Dicranum scoparium	85	10	--	--	03	--	--	--	--
Drepanocladus uncinatus	01	.5	30	--	--	--	--	--	--
Pleurozium schreberi	--	--	05	--	40	--	--	03	--
Polytrichum juniperinum	--	05	--	01	--	.5	--	--	--
Barbilophozia lycopodioides	01	.5	05	.5	.5	--	--	--	--
Cladonia pyxidata	--	.5	.5	--	--	--	--	--	--
Peltigera aphthosa	--	10	05	--	03	--	--	--	--
Peltigera canina	--	01	.5	--	.5	--	--	--	--

Vegetation: Dwarfed *Abies lasiocarpa* (10-50%) dominates the shrub layer (40-90%) (Table 54) with *Salix vestita* (10-25%), *Picea engelmannii* (3-5%) and other *Salix* spp. (5-10%) common. The herb-dwarf shrub layer (20-80%) is varied and typically contains *Valeriana sitchensis* (2-15%), *Arnica cordifolia* (2-5%), *Epilobium angustifolium* (<1-3%), *Fragaria virginiana* (1-5%), *Pedicularis bracteosa* (1-2%), *Thalictrum occidentale* (2-3%) and *Vaccinium scoparium* (<1-10%). Bryoid layer cover is variable with *Dicranum scoparium*, *Barbilophozia hatcheri* and *Cladonia* spp. most important.

S2 is successionally mature, maintained by periodic avalanches, although it has some characteristics of earlier successional stages. S2 is distinguished by its dominance by *Abies lasiocarpa* and occurrence on snow avalanche tracks.

Other Studies: S2 is also described in BNP and JNP (Corns and Achuff 1982) and in MRNP and

GNP (Achuff and Dudynsky 1984). In British Columbia, similar types are described by Kuchar (1978, deciduous avalanche scrub) in Yoho National Park. In Alberta, Trottier and Scotter (1973, *Picea-Abies/Alnus crispa-Vaccinium scoparium/Heracleum lanatum*) have a similar type in BNP. Butler (1979) describes a comparable type in Glacier National Park, Montana.

S4: *Salix* spp.-*Betula glandulosa/Erigeron peregrinus*

(willow-dwarf birch/fleabane)

Environment: S4 occurs on hygric to mesic Upper Subalpine (2000-2300 m) sites with nearly level to moderate slopes on all aspects. Soils are moderately well to poorly drained Gleysolic, Regosolics and Brunisolics on fluvial and morainal landforms. Only one stand, at Ottertail Pass, was sampled in KNP.

Vegetation: S4 is dominated by *Salix glauca* (10-50%) with *Betula glandulosa* and other *Salix* spp. often present (Table 55). The herb-dwarf shrub layer (45-85%) is dominated by *Erigeron peregrinus* (5-30%) with *Fragaria virginiana* (1-10%) and *Potentilla diversifolia* (1-3%) also important. Other common species include *Achillea millefolium*, *Phleum alpinum*, *Valeriana sitchensis* and *Trollius albiflorus*. Bryoid layer cover is usually 15 to 50% and *Aulacomnium palustre*, *Tomenthypnum nitens* and *Dicranum scoparium* are most common.

S4 is mature successionally. It is differentiated from S8 by having greater cover of *Salix glauca* and *Betula glandulosa*, whereas S8 is dominated by *Salix barrattiana*. Intergrades between S4 and S8 occur.

Other Studies: S4 is also described in BNP and JNP (Corns and Achuff 1982). No similar types are described by other authors in British Columbia. In Alberta, similar vegetation is described from the Kananaskis area by Kondla (1978, birch wetland) and Kirby and Ogilvie (1969).

S5: *Pinus contorta/Linnaea borealis-Epilobium angustifolium*

(lodgepole pine/twinflower-fireweed)

Environment: S5 occurs in northern KNP in the 1968 Vermilion Pass burn on mesic Lower Subalpine (1620-1860 m) sites on a variety of slopes and aspects. Soils are well drained Brunisolics on glacial landforms.

Vegetation: *Pinus contorta* (5-30%) dominates the shrub layer (15-35%) (Table 56) with *Menziesia glabella* (2-4%) also often present. The herb-dwarf shrub layer (35-65%) is species-rich. Predominant species include *Linnaea borealis* (5-20%), *Vaccinium scoparium* (10-15%), *Cornus canadensis* (2-10%) and *Epilobium angustifolium* (10-25%). Other frequent species are *Arnica cordifolia*, *Aster ciliolatus*, *Taraxacum officinale* and *Fragaria virginiana*. Bryoid layer cover is variable with *Ceratodon purpureus*, *Polytrichum juniperinum* and *Bryum caespiticium* most common.

S5 is successionally at an early stage, having originated 15 years ago. Succession will be to a *Pinus contorta* forest but it could be any of several v.t.s. The presence of *Menziesia glabella* in some stands suggests development to lodgepole pine/false azalea/grouseberry (C20). Other stands with *Vaccinium scoparium* may develop to lodgepole pine/buffaloberry/grouseberry (C18), those with much *Linnaea borealis* to lodgepole pine/buffaloberry/twinflower (C19) and those with *Aster conspicuus* to lodgepole pine/buffaloberry/showy aster (C6). Further work is needed to more accurately predict these successional changes.

S5 is distinguished by the dominance of shrub-size *Pinus contorta* and young age.

Other Studies: No vegetation similar to S5 is described by other authors.

Table 55. Stands of the willow-dwarf birch/fleabane (S4) v.t. Values are percent cover.

	JC	JD	JD	JD	KS	PA	PA	PA	HD
	80	50	80	80	51	80	80	80	20
	56	44	31	70	32	70	78	90	80
SHRUB LAYER									
Betula glandulosa	10	--	01	60	05	50	75	40	--
Potentilla fruticosa	20	--	.5	--	10	--	.5	--	.5
Salix barrattiana	15	10	20	03	05	05	10	.5	--
Salix farrae	--	--	10	--	15	--	--	15	--
Salix glauca	25	25	50	20	60	05	05	30	50
HERB-DWARF SHRUB LAYER									
Achillea millefolium	03	07	.5	01	.5	.5	.5	02	--
Agoseris glauca	--	.5	--	.5	--	.5	.5	--	--
Antennaria lanata	--	--	--	--	--	02	--	--	15
Antennaria nitida	--	--	--	.5	--	--	--	--	01
Astragalus alpinus	--	.5	--	--	.5	--	--	02	--
Castilleja occidentalis	02	--	--	01	--	.5	--	--	--
Delphinium glaucum	--	--	.5	02	--	--	.5	05	--
Deschampsia caespitosa	01	--	01	--	--	--	--	10	--
Elymus innovatus	--	02	--	20	--	05	05	--	--
Epilobium angustifolium	--	15	--	01	--	--	--	--	.5
Erigeron peregrinus	15	02	15	30	03	02	01	15	40
Fragaria virginiana	08	10	15	.5	05	--	--	--	.5
Phleum alpinum	02	01	--	--	.5	--	--	.5	--
Poa alpina	--	05	.5	01	--	--	--	.5	--
Potentilla diversifolia	03	.5	.5	05	--	01	.5	--	.5
Senecio lugens	05	--	01	--	--	01	.5	01	--
Senecio triangularis	--	.5	--	--	--	--	--	--	.5
Sibbaldia procumbens	01	--	--	.5	--	--	--	--	.5
Solidago multiradiata	01	--	01	01	--	.5	--	.5	--
Trisetum spicatum	--	.5	--	15	.5	--	--	--	--
Trollius albiflorus	10	05	--	--	02	.5	--	--	--
Valeriana sitchensis	--	01	02	20	--	--	--	03	10
BRYOID LAYER									
Bryoerythrophyllum recurvirostrum	02	--	.5	--	--	--	--	--	--
Bryum spp.	--	.5	.5	.5	--	--	--	--	--
Desmatodon latifolius	--	--	--	.5	--	--	.5	--	--
Polytrichum juniperinum	--	--	--	01	--	--	--	--	50
Pseudoleskea radicosa var. compacta	--	.5	--	.5	--	--	--	--	--
Tortella tortuosa	--	.5	--	--	--	--	.5	--	--
Tortula norvegica	--	.5	.5	--	10	--	.5	--	--
Tortula ruralis	--	--	--	05	--	10	--	--	--

S8: *Salix barrattiana/Potentilla diversifolia*

(willow/cinquefoil)

Environment: S8 occurs on subhygric to hygric Upper Subalpine (1900-2330 m) sites in northern KNP on gentle to moderate slopes of various aspects. Soils are moderately well to poorly drained Regosolics and Gleysolics on fluvial landforms.

Vegetation: *Salix barrattiana* (20-60%) dominates the shrub layer (50-90%) (Table 57). *Salix glauca* (5-20%) is also often present. The herb-dwarf shrub layer (30-70%) is species-rich with many species having low cover. Commonly important are *Potentilla diversifolia* (1-5%), *Erigeron peregrinus* (2-10%) and *Trollius albiflorus* (3-15%). Other species with low cover include *Fragaria virginiana*, *Valeriana sitchensis*, *Pedicularis bracteosa*, *Senecio triangularis* and *Achillea millefolium*. Bryoid layer cover is usually low with *Tortula* spp. and *Brachythecium* spp. most common.

S8 is successionally mature. Dominance of *Salix barrattiana* differentiates S8 from S4 and intergrades between them occur.

Table 56. Stands of the lodgepole pine/twinflower-fireweed (S5) v.t. Values are percent cover.

	HD	HD	HD	HD	MF	MF
	10	11	11	20	20	20
	23	31	32	39	54	55
SHRUB LAYER						
Ledum glandulosum	--	--	--	--	02	02
Menziesia glabella	28	--	--	02	03	04
Pinus contorta	07	33	12	16	35	09
Rhododendron albiflorum	--	--	35	--	--	--
Salix scouleriana	--	--	--	.5	02	--
Salix sp.	--	--	--	--	01	01
Sambucus melanocarpa	--	--	--	--	01	01
HERB-DWARF SHRUB LAYER						
Antennaria pulcherrima	--	--	--	08	--	--
Arnica cordifolia	10	--	--	04	02	02
Aster ciliolatus	--	08	04	.5	06	--
Aster conspicuus	--	01	02	.5	03	--
Carex platylepis	--	--	--	--	.5	01
Cornus canadensis	07	--	02	10	05	02
Elymus innovatus	--	.5	.5	--	--	--
Epilobium angustifolium	20	02	--	10	30	16
Fragaria virginiana	--	01	--	.5	.5	--
Hieracium albiflorum	--	--	04	--	--	01
Linnaea borealis	20	10	30	05	03	04
Picea engelmannii	--	--	--	--	01	.5
Potentilla fruticosa	--	02	--	02	--	--
Pyrola secunda	.5	--	--	--	--	01
Taraxacum officinale	--	--	.5	05	.5	01
Thalictrum occidentale	--	--	--	.5	.5	--
Vaccinium myrtillus	--	--	03	--	.5	--
Vaccinium scoparium	25	--	02	15	09	08
Lycopodium clavatum	--	--	--	--	.5	.5
BRYOID LAYER						
Bryum caespiticium	.5	.5	.5	03	--	--
Ceratodon purpureus	90	.5	--	02	.5	--
Polytrichum juniperinum	.5	--	75	65	--	55
Peltigera canina	--	--	05	--	01	--

Other Studies: S8 is also described in BNP and JNP (Corns and Achuff 1982). No similar types have been described by other authors in British Columbia. In Alberta, similar types are described by Crack (1977) and Kuchar (1975) in JNP, by Trottier and Scotter (1973, *Salix barrattiana/Carex nigricans* and *Salix barrattiana-Betula glandulosa/Carex* spp.), Broad (1973), Knapik *et al.* (1973), and Beder (1967) in BNP. Elsewhere in Alberta, comparable types are described by Ogilvie (1976), Mortimer (1978, *Salix barrattiana-Trollius albiflorus*), Jacques and Legge (1974, tall willow), and Trottier (1972).

S13: *Alnus crispa*/fern

(green alder/fern)

Environment: S13 occurs on mesic Lower Subalpine (1590-1670 m) sites in central and northern KNP on moderate to steep slopes of various aspect. They are characteristically snow avalanched. Soils are well to imperfectly drained Regosolics and Brunisolics on colluvial landforms.

Vegetation: *Alnus crispa* (70-95%) dominates the shrub layer (Table 58, Plate 30). The herb-dwarf shrub layer is diverse with *Dryopteris assimilis*, *Gymnocarpium dryopteris*, *Tiarella unifoliata*, *Thalictrum occidentale* and *Streptopus amplexifolius* prominent. Bryoid layer cover is low with *Brachythecium* spp. common.

Table 57. Stands of the willow/cinquefoil (S8) v.t. Values are percent cover.

	AW	JD	JD	JE	PA	PA	HD	SD	MF
	51	50	80	80	70	80	20	20	20
	33	51	37	33	24	80	71	80	73
SHRUB LAYER									
Potentilla fruticosa	--	15	--	--	15	--	--	25	--
Salix barrattiana	09	50	75	50	35	50	--	35	40
Salix glauca	--	20	03	25	--	10	--	30	40
Salix spp.	--	--	07	--	--	--	75	--	02
HERB-DWARF SHRUB LAYER									
Achillea millefolium	--	05	--	.5	--	--	--	02	02
Antennaria lanata	.5	--	--	--	01	--	.5	--	--
Aquilegia flavescens	.5	--	.5	03	02	--	--	--	--
Arnica latifolia	--	--	02	--	.5	--	10	--	--
Carex atrosquama	--	--	03	--	--	--	--	.5	--
Carex scirpoidea	--	--	01	--	03	--	.5	--	--
Epilobium angustifolium	--	03	--	--	--	.5	--	02	01
Erigeron peregrinus	.5	02	15	.5	--	10	--	02	--
Fragaria virginiana	.5	60	20	--	--	--	.5	10	03
Myosotis alpestris	--	--	.5	.5	--	.5	--	--	--
Pedicularis bracteosa	.5	--	01	--	15	--	.5	--	--
Phleum alpinum	.5	--	--	--	--	01	--	--	.5
Poa alpina	01	--	01	--	--	--	--	--	01
Polygonum viviparum	.5	--	01	.5	01	--	--	--	--
Potentilla diversifolia	.5	.5	05	02	.5	10	.5	--	.5
Salix arctica	04	--	01	--	.5	--	--	--	--
Senecio indecorus	.5	05	.5	--	--	--	--	--	--
Trollius albiflorus	.5	--	10	08	20	10	35	--	--
Valeriana sitchensis	.5	--	15	01	02	10	--	03	--
BRYOID LAYER									
Tortula spp.	--	--	.5	01	.5	05	--	03	--
Brachythecium spp.	--	.5	.5	.5	.5	.5	--	--	--
Bryum spp.	--	.5	.5	.5	.5	05	.5	--	--
Peltigera aphthosa	--	.5	--	.5	--	--	--	--	--

S13 is successionally mature, maintained by periodic avalanching. It differs from S2, which is also frequently avalanched, by the dominance of *Alnus crispa* and occurring mainly in the Lower Subalpine whereas S2 is dominated by *Abies lasiocarpa* and occurs mainly in the Upper Subalpine.

Other Studies: S13 is also described in MRNP and GNP (Achuff and Dudynsky 1984). No similar types are described by other authors.

S16: *Populus tremuloides-Betula glandulosa/Arctostaphylos uva-ursi*

(aspen-dwarf birch/bearberry)

Environment: S16 occurs throughout KNP on mesic to subxeric Lower Subalpine sites (1770-1970 m) on moderate to very steep slopes with southerly and westerly aspects which are snow avalanched (Plate 50). Soils are well to rapidly drained Orthic Humic Regosols on colluvial landforms.

Vegetation: The shrub layer (Table 59) is characterized by *Populus tremuloides* (5-20%), *Amelanchier alnifolia* (2-15%), *Acer glabrum* (<1-10%) and *Shepherdia canadensis* (1-30%). The herb-dwarf shrub layer is usually dominated by *Arctostaphylos uva-ursi* (20-40%) with *Hedysarum sulphurescens* (3-5%), *Fragaria virginiana* (2-3%), *Potentilla argentea* (1-2%) and *Achillea millefolium* (<1-3%) also common. Bryoid layer cover is low with *Tortella tortuosa* most frequent.

Table 58. Stands of the green alder/fern (S13) v.t. Values are percent cover.

	HD	HD	HD	MF	MF	SD
	20	20	21	20	20	20
	76	94	32	51	91	28
SHRUB LAYER						
Alnus crispa	65	95	80	95	99	70
Lonicera involucrata	--	--	.5	02	--	--
Menziesia glabella	--	--	--	20	03	--
Oplopanax horridum	--	--	05	03	--	--
Ribes lacustre	03	--	--	14	--	--
Rubus strigosus	05	--	--	--	--	--
Sambucus melanocarpa	--	--	--	13	--	--
Smilacina racemosa	10	--	--	--	--	--
HERB-DWARF SHRUB LAYER						
Alnus crispa	--	.5	--	04	--	03
Heracleum lanatum	--	--	--	02	--	.5
Mitella nuda	--	02	.5	--	--	--
Ribes lacustre	--	05	--	--	--	.5
Rubus parviflorus	--	--	05	01	--	--
Rubus strigosus	--	--	--	03	--	.5
Smilacina racemosa	--	--	.5	01	--	.5
Streptopus amplexifolius	--	08	--	01	01	.5
Thalictrum occidentale	14	10	.5	11	--	--
Tiarella unifoliata	--	10	.5	08	02	--
Urtica sp.	05	--	.5	--	--	--
Veratrum eschscholtzii	--	--	--	--	--	03
Viola orbiculata	05	--	--	--	--	--
Dryopteris assimilis	--	55	03	03	75	--
Gymnocarpium dryopteris	--	--	02	15	07	05
BRYOID LAYER						
Brachythecium curtum	--	.5	--	--	--	.5
Brachythecium sp.	.5	--	--	--	05	--

S16 is successionally mature and maintained by frequent snow avalanching. It differs from other shrub v.t.s by the dominance of *Populus tremuloides*.

ther Studies: Clement (1981) recognizes two similar types (trembling aspen-willow-pine rass-western meadow rue and trembling aspen-fireweed-Canada bunchberry) in the Vernon area.

LOW SHRUB-HERB VEGETATION TYPES

L5: *Phyllodoce glanduliflora-Cassiope mertensiana-Antennaria lanata*

(heather-everlasting)

Environment: L5 occurs on mesic Upper Subalpine to Alpine sites (2190-2510 m) with gentle to moderate slopes and usually with a southerly or westerly aspect (Plate 41). Well drained Eutric and Dystric Brunisols, and occasionally Orthic Humo-Ferric Podzols occur on morainal landforms. The terrain is often gullied, failed or soliflucted.

Vegetation: L5 is dominated by *Phyllodoce glanduliflora* (10-50%), *Cassiope mertensiana* (15-35%) and *Antennaria lanata* (2-20%) (Table 60). Other prominent species include *Phyllodoce empetriformis* (3-10%) and *Vaccinium scoparium* (2-10%). Characteristic species with low cover are *Anemone occidentalis, Carex nigricans, Erigeron peregrinus, Hieracium gracile, Juncus drummondii, Luzula* spp., *Poa alpina* and *Sibbaldia procumbens*. Total herb-dwarf shrub layer cover is 60 to 90%. Bryoid cover is variable (3-50%) with *Dicranum scoparium, Polytrichum juniperinum, Pogonatum alpinum* and *Cladonia ecmocyna* most common.

Table 59. Stands of the aspen-dwarf birch/bearberry (S16) v.t. Values are percent cover.

	HD 10 21	HD 11 15	HD 21 14	HD 21 19	JD 10 27
	SHRUB	LAYER			
Abies lasiocarpa	--	.5	--	02	--
Acer glabrum	--	.5	.5	--	14
Amelanchier alnifolia	02	08	--	--	18
Betula glandulosa	--	15	--	--	--
Populus tremuloides	--	20	--	04	13
Salix glauca	--	03	--	--	--
Shepherdia canadensis	--	.5	.5	01	30
	HERB-DWARF	SHRUB	LAYER		
Achillea millefolium	--	.5	.5	--	03
Allium cernuum	--	--	.5	.5	01
Arctostaphylos uva-ursi	35	20	--	20	40
Aster ciliolatus	.5	02	--	.5	--
Aster sibiricus	--	--	--	.5	01
Campanula rotundifolia	--	.5	--	--	02
Erigeron peregrinus	--	--	01	--	01
Fragaria virginiana	02	.5	40	--	03
Gentiana amarella	--	--	.5	--	01
Hedysarum sulphurescens	05	.5	03	.5	05
Juniperus communis	--	05	--	15	--
Linnaea borealis	--	.5	--	--	05
Potentilla fruticosa	02	01	--	15	--
Ribes lacustre	--	.5	01	--	--
Rubus strigosus	--	.5	--	.5	--
Spiraea lucida	--	--	10	.5	--
Zygadenus elegans	02	.5	--	--	--
Senecio sp.	--	.5	--	.5	--
Thalictrum sp.	.5	.5	--	--	--
Aquilegia sp.	--	--	.5	01	--
	BRYOID	LAYER			
Brachythecium salebrosum	.5	--	--	--	--
Bryoerythrophyllum recurvirostrum	.5	--	--	--	--
Ditrichum flexicaule	--	--	20	--	--
Tortella tortuosa	.5	.5	07	--	--
Cladonia fimbriata	--	--	10	--	--
Cladonia pocillum	--	--	10	--	--
Cladonia pyxidata	--	--	10	--	--
Peltigera canina	--	--	15	--	--

L5 is successionally mature and is distinguished by the dominance of *Phyllodoce glanduliflora*, *Phyllodoce empetriformis* and *Cassiope mertensiana*. Stands which intergrade with O10, O13 and C23 occur near the Alpine-Upper Subalpine boundary.

Other Studies: L5 is also described in BNP and JNP (Corns and Achuff 1982) and in MRNP and GNP (Achuff and Dudynsky 1984). Numerous other workers describe types similar to L5. In British Columbia, similar types are described by Knapik and Landals (1974, *Cassiope mertensiana*) in MRNP, by Kuchar (1978, mountain heather tundra) in Yoho National Park, by Eady (1971, *Phyllodoce empetriformis-Antennaria lanata*, and by Lea (1984, mountain heather-grouseberry-wooly pussytoes). In JNP, similar types are noted by Crack (1977, *Phyllodoce glanduliflora*), Hrapko and La Roi (1978, *Cassiope mertensiana-Phyllodoce glanduliflora*), Kuchar (1975, *Phyllodoce glanduliflora-Cassiope mertensiana*), and La Roi (1975, *Abies lasiocarpa/Cassiope mertensiana/Pseudoleskea radicosa*). Elsewhere in Alberta, Ogilvie (1976, *Phyllodoce*), Kondla (1978, everlasting-phyllodoce),

Table 60. Stands of the heather-everlasting (L5) v.t. Values are percent cover.

	BB	HD	HD	HD	MF	MF	MF	SD	SD	SD
	10	11	20	20	20	20	20	20	20	20
	27	24	69	91	79	84	93	44	59	61
	HERB-DWARF SHRUB LAYER									
Anemone drummondii	.5	--	.5	--	--	--	--	--	--	--
Anemone occidentalis	--	--	--	.5	.5	01	10	.5	.5	.5
Antennaria lanata	05	20	40	08	02	08	10	08	.5	15
Arnica cordifolia	--	--	--	--	--	--	--	.5	.5	--
Arnica latifolia	--	03	--	05	--	--	--	--	--	--
Carex nigricans	.5	--	--	--	05	--	.5	--	10	10
Carex phaeocephala	--	15	--	--	--	--	--	--	--	--
Carex scirpoidea	--	--	--	--	--	--	20	--	--	--
Cassiope mertensiana	--	--	--	35	03	--	--	.5	05	.5
Castilleja miniata	--	--	--	--	--	--	05	05	.5	--
Claytonia lanceolata	01	--	--	--	01	--	02	.5	--	.5
Dryas octopetala	--	.5	01	--	--	--	--	--	--	--
Erigeron peregrinus	--	.5	--	.5	--	04	02	--	05	.5
Juncus drummondii	--	.5	--	.5	.5	02	--	--	--	--
Larix lyallii	--	--	02	.5	.5	01	--	--	.5	.5
Luzula glabrata	.5	--	--	05	.5	09	--	--	--	--
Luzula spicata	.5	15	--	--	.5	--	--	--	--	--
Luzula wahlenbergii	--	--	.5	--	07	--	--	03	--	03
Pedicularis bracteosa	01	--	--	.5	.5	--	--	05	03	01
Phyllodoce empetriformis	--	--	--	15	--	--	08	--	--	--
Phyllodoce glanduliflora	40	--	40	25	60	70	10	15	50	50
Poa alpina	.5	05	.5	.5	--	.3	--	--	--	--
Polygonum viviparum	--	--	.5	--	--	--	--	.5	--	--
Potentilla diversifolia	--	.5	.5	--	.5	--	.5	.5	.5	--
Ranunculus eschscholtzii	01	--	--	.5	01	.5	02	02	--	.5
Salix arctica	.5	.5	.5	--	03	.5	--	10	--	--
Salix nivalis	.5	03	17	--	--	--	--	10	--	.5
Senecio triangularis	.5	.5	--	.5	--	.5	08	03	--	.5
Sibbaldia procumbens	--	.5	.5	.5	.5	--	--	.5	--	02
Solidago multiradiata	.5	--	04	--	--	--	--	--	--	--
Vaccinium scoparium	05	08	--	03	02	--	08	10	--	--
	BRYOID LAYER									
Dicranum scoparium	--	--	35	.5	--	--	--	--	--	01
Pogonatum alpinum	.5	--	--	.5	.5	--	--	--	--	--
Polytrichum juniperinum	--	--	04	45	--	--	--	--	--	--
Tortula ruralis	01	--	--	--	--	--	--	03	.5	03
Dicranum sp.	--	--	10	.5	--	--	--	--	--	--
Cetraria islandica	01	--	03	--	--	--	--	--	--	--
Cladonia carneola	--	--	--	--	--	--	--	--	.5	01
Cladonia ecmocyna	--	--	.5	.5	--	--	--	01	--	--
Peltigera rufescens	.5	--	--	--	01	--	--	--	--	--
Cladonia sp.	01	--	--	--	01	--	--	--	--	--

Kirby and Ogilvie (1969, *Phyllodoce*), Mortimer (1978, *Phyllodoce glanduliflora-Cassiope mertensiana*), Jacques and Legge (1974, yellow heather) and Trottier (1972, *Phyllodoce*) describe similar types.

L7: *Salix arctica-Potentilla diversifolia*

(arctic willow-cinquefoil)

Environment: L7 occurs on mesic to subhygric Upper Subalpine to Alpine sites (2180-2420 m) on a wide variety of slopes and aspects in central and northern KNP. Soils are well to imperfectly drained Brunisolics and Regosolics on colluvial, morainal and fluvial landforms. Sites are often soliflucted and lie in deep snow accumulation areas which receive seepage much of the growing season.

Vegetation: The herb-dwarf shrub layer (45-75%) (Table 61) is dominated by ***Salix arctica*** (10-35%), *Potentilla diversifolia* (1-3%) and *Antennaria lanata* (5-20%). Other characteristic species with low cover include *Anemone occidentalis*, *Erigeron aureus*, *Erigeron peregrinus*, *Poa alpina*, *Saxifraga lyallii* and *Veronica alpina*. Bryoid cover is generally low (5-15%) with *Tortula ruralis*, *Cladonia gonecha* and *Polytrichum juniperinum* most common.

Table 61. Stands of the arctic willow-cinquefoil (L7) v.t. Values are percent cover.

	BB	HD	SD	SD	SD
	10	21	20	20	21
	29	15	65	66	38
	HERB-DWARF SHRUB LAYER				
Anemone occidentalis	.5	.5	10	.5	--
Antennaria lanata	03	15	20	05	--
Arnica cordifolia	01	--	--	.5	.5
Carex scirpoidea	--	--	05	10	--
Erigeron aureus	--	10	02	10	--
Erigeron peregrinus	--	05	--	02	.5
Fragaria virginiana	--	.5	--	.5	--
Juncus drummondii	--	01	.5	--	--
Parnassia fimbriata	--	--	.5	--	.5
Pedicularis bracteosa	--	.5	--	.5	--
Phleum alpinum	--	05	--	.5	--
Poa alpina	.5	05	.5	.5	.5
Potentilla diversifolia	--	01	05	03	--
Salix arctica	30	50	20	10	10
Saxifraga lyallii	--	--	.5	.5	02
Senecio triangularis	.5	--	05	.5	--
Sibbaldia procumbens	--	--	--	.5	03
Trisetum spicatum	--	--	--	.5	05
Vaccinium scoparium	--	01	.5	--	--
Valeriana sitchensis	.5	--	--	--	01
Veronica alpina	--	.5	.5	.5	02
Sedum lanceolatum	.5	--	--	05	--
	BRYOID LAYER				
Mnium blyttii	--	.5	--	--	--
Mnium lycopodioides	--	.5	--	--	--
Polytrichum juniperinum	--	.5	.5	02	--
Cladonia gonecha	--	.5	--	--	--
Cladonia pyxidata	--	--	--	--	.5
Peltigera aphthosa	--	05	--	--	--
Rhizocarpon geographicum	.5	--	--	--	--

L7 is successionally mature. It is similar to H16 with many characteristic species in common. However, L7 is dominated by *Salix arctica* and the H16 dominants *Valeriana sitchensis*, *Trollius albiflorus* and *Anemone occidentalis* are generally absent or with low cover in L7. H2 also occurs in snow accumulation areas but in H2, meltout occurs later and *Carex nigricans* is dominant.

Other Studies: L7 is also described in BNP and JNP (Corns and Achuff 1982). A similar type is described in British Columbia by Kuchar (1978, variegated horsetail/arctic willow/moss meadow). In Alberta, similar types are described by Crack (1977, *Salix arctica*) and Hrapko and La Roi (1978, *Salix arctica-Antennaria lanata*, *Salix arctica-Arctagrostis arundinacea*) in JNP and by Beder (1967, *Salix arctica/Carex*) in BNP. Elsewhere in Alberta, similar vegetation is described by Mortimer (1978, *Salix arctica/Salix nivalis*), Jacques and Legge (1974, dwarf arctic willow), Trottier (1972, *Salix arctica*), Ogilvie (1976, *Salix nivalis-Salix arctica*), and Kondla (1978, valeriana-anemone-willow).

HERB-DWARF SHRUB VEGETATION TYPES

H1: *Dryas octopetala-Salix nivalis-Silene acaulis*

(mountain avens-snow willow-moss campion)

Environment: H1 occurs on mesic to subxeric Alpine sites (2300-2610 m) throughout KNP on various slopes and southerly to westerly aspects. Soils are well drained Regosolics and Brunisolics developed on colluvial and morainal landforms. Solifluction is common.

Vegetation: H1 tundra has total herb-dwarf shrub layer cover of 20 to 80% (Table 62) with *Dryas octopetala* (10-50%) and *Salix nivalis* (3-20%) dominant. Other common species with low cover are *Saxifraga oppositifolia, Potentilla diversifolia, Oxytropis podocarpa, Carex scirpoidea, Anemone drummondii, Astragalus alpinus, Erigeron aureus, Antennaria lanata* and *Salix arctica.* Bryoid cover is generally <10% with *Cetraria tilesii, Cetraria ericetorum, Cetraria nivalis, Cetraria cucullata, Lecidea* spp., *Peltigera rufescens* and *Tortula* spp. most common. H1 occupies wind-swept sites with low winter snow cover and often forms a pattern in the landscape with L5, L7 and H2 occurring in progressively deeper snowbeds.

Table 62. Stands of the mountain avens-snow willow-moss campion (H1) v.t. Values are percent cover.

	HD	HD	HD	HD	SD	SD	SD	SD	SD	SD
	20	20	20	21	20	20	20	20	20	20
	50	51	96	00	29	37	48	71	81	86
HERB-DWARF SHRUB LAYER										
Anemone drummondii	--	05	--	--	.5	03	.5	--	--	--
Anemone parviflora	--	--	--	--	--	--	--	.5	.5	.5
Astragalus alpinus	--	--	--	--	.5	.5	05	--	--	--
Carex nardina	01	--	05	03	--	--	--	--	--	--
Carex scirpoidea	--	--	--	--	--	02	05	02	05	--
Dryas octopetala	10	60	15	20	35	40	05	05	50	05
Erigeron aureus	.5	.5	--	--	--	.5	--	02	--	--
Oxytropis podocarpa	--	--	05	01	--	--	--	--	05	.5
Poa alpina	--	--	--	--	--	--	--	.5	.5	02
Polygonum viviparum	--	--	--	--	03	05	--	.5	.5	--
Potentilla diversifolia	.5	08	--	--	.5	.5	--	--	--	.5
Salix arctica	--	--	--	02	--	--	02	03	--	--
Salix nivalis	--	.5	.5	.5	05	20	20	03	03	.5
Saussurea densa	.5	--	--	--	.5	--	--	--	02	.5
Saxifraga oppositifolia	--	--	--	01	.5	02	03	.5	--	.5
Silene acaulis	.5	--	--	--	.5	--	--	--	--	--
BRYOID LAYER										
Tortula ruralis	--	--	.5	--	10	05	02	--	01	--
Cetraria cucullata	--	--	--	--	.5	--	--	--	.5	01
Cetraria tilesii	.5	--	.5	--	.5	--	--	--	.5	01
Peltigera rufescens	--	--	--	--	.5	--	--	.5	--	01
Rhizocarpon geographicum	.5	15	--	--	--	--	--	--	--	--
Xanthoria elegans	--	--	--	--	.5	--	--	--	.5	.5
Cornicularia sp.	--	--	.5	--	--	--	--	--	.5	.5
Lecidea sp.	--	--	--	--	.5	--	.5	.5	--	.5

H1 is successionally mature and is characterized by the dominance of *Dryas octopetala*. Intergrades with L5 occur.

Other Studies: H1 is also described in BNP and JNP (Corns and Achuff 1982) and in MRNP and

GNP (Achuff and Dudynsky 1984). In British Columbia, similar types are described by Kuchar (1978, white dryad tundra) in Yoho National Park and by Raup (1934) in the Mount Selwyn area in northeastern British Columbia. In Alberta, similar types are described by many workers. In JNP, these include Hettinger (1975, *Dryas octopetala-Oxytropis campestris*) Hrapko and La Roi (1978; *Dryas octopetala-Oxytropis campestris*, *Dryas octopetala-Festuca brachyphylla*, *Dryas octopetala-Salix nivalis*), La Roi (1975, *Dryas octopetala/Salix nivalis-Polytrichum piliferum/Rhizocarpon geographicum*, *Dryas octopetala/Salix nivalis/Rhacomitrium lanuginosum/Rhizocarpon geographicum*), Kuchar (1975, *Dryas octopetala*/lichen, *Dryas octopetala/Polytrichum piliferum*), and Crack (1977, *Dryas octopetala*). In BNP, similar vegetation is described by Broad (1973, *Dryas octopetala-Empetrum nigrum*), Trottier and Scotter (1973, *Dryas octopetala*, *Salix nivalis*), Beder (1967, *Dryas hookeriana-Oxytropis podocarpa-Cetraria cucullata-Cetraria nivalis*), and Knapik *et al.* (1973, *Dryas hookeriana*, *Dryas hookerina-Carex scirpiformis*). Elsewhere in Alberta, similar types are described by Mortimer (1978, *Dryas integrifolia-Oxytropis podocarpa*) and See and Bliss (1980, *Dryas integrifolia-Oxytropis podocarpa-Salix myrtillifolia*) in the northern Front Ranges, in the Kananaskis area by Kirby and Ogilvie (1969, *Dryas*), Jacques and Legge (1974, *Dryas octopetala*), Kondla (1978, mountain avens), and Trottier (1972, *Dryas octopetala*), in the upper Oldman River area by Jeffrey *et al.* (1968, alpine tundra), Ogilvie (1976, *Dryas hookeriana)*, and by Kuchar (1973, *Dryas* tundra) in Waterton Lakes National Park. Similar types occur further south as described by Bamberg and Major (1968) in central Montana, Choate and Habeck (1967) on fellfields in Glacier National Park, Montana and Johnson and Billings (1962, *Dryas octopetala*) in southern Montana.

H2: *Carex nigricans-Antennaria lanata*

(black alpine sedge-everlasting)

Environment: H2 occurs throughout the Alpine (2200-2500 m) of KNP on mesic to subhygric sites on a wide range of slopes and aspects. The soils are moderately well drained Dystric Brunisols and Regosolics developed on morainal and colluvial landforms often with a fluvial veneer.

Vegetation: Total cover of the herb-dwarf shrub layer is 70 to 80% (Table 63) with *Carex nigricans* (10-75%) often forming a turf. Other common species include *Antennaria lanata* (1-35%), *Sibbaldia procumbens* (1-5%), *Salix arctica* (1-2%), *Ranunculus eschscholtzii* (≤1%) and *Veronica alpina* (<1%). The bryoid layer has a total cover of 10 to 15%, with 10 to 30% of unvegetated mineral soil. Common species are *Tortula norvegica* (1-10%) and *Cladonia* spp. (1-2%).

H2 is mature successionally and is distinguished by the dominance of *Carex nigricans*. It usually occurs in small patches in late snow lie areas which receive melt water until late season. H2 often is part of a v.t. pattern in the landscape in which H2, L7, L5 and H1 occupy progressively shallower snow lie areas.

Other Studies: H2 is also described in BNP and JNP (Corns and Achuff 1982) and in MRNP and GNP (Achuff and Dudynsky 1984). *Carex nigricans* dominated vegetation is widespread. In British Columbia, similar types are described by Kuchar (1978, black alpine sedge types) in Yoho National Park, by Knapik and Landals (1974, *Carex nigricans*) in MRNP, and by Eady (1971, *Carex nigricans*). In Alberta, similar vegetation is described by Kuchar (1975, *Carex nigricans*), Hrapko and La Roi (1978, *Carex nigricans-Luzula wahlenbergii*), and Crack (1977, *Carex nigricans*) in JNP, and by Trottier and Scotter (1973, *Carex nigricans* types), Broad (1973, *Carex nigricans*), Beder (1967, *Carex nigricans*), and Knapik *et al.* (1973, *Carex nigricans*) in BNP. Elsewhere in Alberta, similar types are described by Ogilvie (1976, Kirby and Ogilvie 1969; *Carex nigricans*), Jacques and Legge (1974, black sedge), Trottier (1972, *Carex nigricans*), and Kondla (1978, alpine sedge-buttercup).

H5: *Elymus innovatus-Fragaria virginiana-Epilobium angustifolium*

(hairy wild rye-wild strawberry-fireweed)

Environment: H5 grasslands occur on mesic, Upper Subalpine (1800-2250 m) sites with steep slopes and southerly to westerly aspects. Soils are well drained Melanic and Eutric Brunisols and Regosolics developed on colluvial and morainal landforms. The sites are often snow avalanched. H5 is not common in KNP and only two stands were sampled. HD2053 (Table 64) is from northern KNP near Vermilion Pass and fits well the H5 concept developed in BNP and JNP. JD1038 is from McKay Creek in southern KNP and fits H5 only peripherally.

Table 63. Stands of the black alpine sedge-everlasting (H2) v.t. Values are percent cover.

	HD	SD	AW	KS	KS	PA
	21	20	50	50	51	70
	06	33	95	55	14	79
	HERB-DWARF SHRUB LAYER					
Achillea millefolium	--	05	--	--	--	--
Anemone drummondii	--	02	--	--	--	--
Anemone occidentalis	--	--	08	10	25	--
Antennaria lanata	--	03	40	20	25	--
Antennaria nitida	.5	--	.5	--	--	--
Arnica mollis	--	05	02	--	.5	--
Carex nigricans	02	60	35	35	20	60
Claytonia lanceolata	--	.5	--	.5	--	.5
Epilobium alpinum	01	--	--	--	.5	--
Erigeron peregrinus	.5	--	--	--	--	--
Juncus drummondii	06	--	.5	03	02	05
Luzula wahlenbergii	--	.5	03	03	.5	--
Phyllodoce glandiflora	--	--	.5	10	03	--
Poa alpina	.5	--	01	--	--	--
Ranunculus eschscholtzii	01	.5	03	08	03	05
Salix arctica	.5	--	02	--	--	--
Salix nivalis	--	10	--	--	--	--
Saussurea densa	--	03	--	--	--	01
Sibbaldia procumbens	.5	05	02	03	01	.5
Veronica alpina	.5	.5	01	--	01	--
Sedum lanceolatum	--	02	--	--	--	--
	BRYOID LAYER					
Desmatodon latifolius	--	.5	--	--	--	.5
Pseudoleskea radicosa var. compacta	.5	--	--	--	.5	01
Tortula norvegica	10	10	--	--	--	01
Brachythecium spp.	.5	--	01	--	--	--
Cetraria spp.	--	.5	.5	--	.5	--
Cladonia cariosa	--	01	--	--	--	--
Cladonia spp.	--	.5	--	--	05	--
Cladonia pyxidata	--	02	--	--	--	--
Peltigera spp.	--	01	--	--	--	.5

Vegetation: Shrub cover is low (<10%) and composed of scattered *Salix* spp., *Rosa acicularis* or *Shepherdia canadensis*. The herb-dwarf shrub layer is well developed (55-100%) and dominated by *Elymus innovatus* (10-55%), *Fragaria virginiana* (1-20%) and *Epilobium angustifolium* (1-10%). Other characteristic species include *Achillea millefolium* (1-5%), *Myosotis alpestris* (1-10%), *Potentilla diversifolia* (<1%), *Heracleum lanatum* (1-10%) and *Zygadenus elegans* (<1-5%). Bryoid layer cover is low (≤15%) with *Tortula* spp. most common.

H5 is mature successionally and avalanches seem important in maintaining the current composition. H5 is distinguished from other herbaceous v.t.s by the dominance of *Elymus innovatus* and occurrence in the Upper Subalpine.

Other Studies: H5 is also described in BNP and JNP (Corns and Achuff 1982). No similar types are described by other authors in British Columbia. In Alberta, similar types are described only from the Front Ranges of the Rocky Mountains. Kirby and Ogilvie (1969) describe a similar "seepage avalanche meadow type" and similar vegetation is noted by Mortimer (1978, *Elymus innovatus-Mertensia paniculata*) in the northern Front Ranges, by Jacques and Legge (1974, *Elymus innovatus*) and Kondla (1978, herb avalanche track) in the Kananaskis area, and Trottier (1972, *Thalictrum occidentale*) near Highwood Pass.

Table 64. Stands of the hairy wild rye-wild strawberry-fireweed (H5) v.t. Values are percent cover.

	AW	JD	PA	PA	PA	HD
	60	80	71	71	80	20
	07	92	58	79	11	53
SHRUB LAYER						
Amelanchier alnifolia	.5	--	--	--	--	--
Populus tremuloides	02	--	--	--	--	--
Rosa acicularis	01	--	--	--	--	--
Salix glauca	--	--	.5	.5	--	.5
HERB-DWARF SHRUB LAYER						
Achillea millefolium	02	.5	05	.5	--	05
Agoseris glauca	--	--	.5	--	--	01
Agropyron latiglume	--	--	08	--	--	--
Allium schoenoprasum	01	--	--	--	--	--
Arctostaphylos uva-ursi	02	.5	--	05	01	--
Arnica cordifolia	.5	--	--	--	--	01
Aster ciliolatus	--	--	10	01	--	--
Aster conspicuus	25	--	--	--	--	--
Aster foliaceus	--	.5	.5	--	--	--
Astragalus alpinus	--	--	01	.5	--	--
Campanula rotundifolia	05	.5	--	--	--	--
Carex praticola	--	--	--	.5	10	--
Castilleja occidentalis	.5	.5	--	--	--	01
Danthonia intermedia	--	10	01	--	--	--
Deschampsia atropurpurea	01	--	--	--	02	--
Elymus innovatus	38	30	20	10	40	10
Epilobium angustifolium	01	.5	05	02	--	05
Festuca saximontana	--	.5	--	02	--	--
Festuca scabrella	--	20	--	--	--	--
Fragaria virginiana	01	15	05	05	.5	25
Gentiana amarella	--	02	02	--	--	--
Hedysarum alpinum	03	--	02	--	--	--
Hedysarum sulphurescens	--	01	--	--	--	03
Juniperus communis	--	--	--	05	03	--
Linnaea borealis	--	--	--	--	10	02
Myosotis alpestris	02	.5	--	--	10	--
Poa alpina	--	.5	--	--	03	--
Poa spp.	--	30	02	05	.5	.5
Potentilla diversifolia	--	40	02	--	20	--
Potentilla fruticosa	--	--	--	.5	--	.5
Senecio pauperculus	--	--	.5	.5	--	--
Trisetum spicatum	--	10	05	.5	--	--
Zygadenus elegans	--	--	--	--	.5	.5
BRYOID LAYER						
Brachythecium groenlandicum	--	--	--	02	--	--
Bryum caespiticium	--	.5	--	--	--	--
Tortula ruralis	--	.5	.5	05	.5	--

H8: *Dryas drummondii-Epilobium latifolium*

(yellow dryad-willow herb)

Environment: H8 occurs on subxeric to subhygric, Montane (1100-1260 m) sites in the Kootenay and Vermilion river valleys (Plate 35). The soils are usually rapidly, but may be imperfectly, drained Orthic Regosols on nearly level fluvial terraces of large rivers.

Vegetation: The herb-dwarf shrub layer has total cover of 35 to 50% with *Dryas drummondii* (10-50%) by far dominant (Table 65). *Potentilla fruticosa* (1-7%), *Poa* spp. (2-5%) and *Fragaria*

Table 65. Stands of the yellow dryad-willow herb (H8) v.t. Values are percent cover.

	AW	PA	PA	PA	BB	HD	MF	PA
	70	70	70	81	10	10	20	10
	41	57	92	69	23	19	11	78
SHRUB LAYER								
Picea engelmannii	03	--	03	05	--	.5	--	--
Salix brachycarpa	01	05	--	--	--	--	--	--
Salix farrae	--	05	--	--	--	--	01	--
Shepherdia canadensis	--	01	.5	--	--	--	--	--
HERB-DWARF SHRUB LAYER								
Anemone parviflora	--	01	--	--	--	.5	--	--
Antennaria pulcherrima	--	05	--	--	--	--	--	--
Arctostaphylos uva-ursi	--	.5	--	--	--	02	--	--
Campanula rotundifolia	--	--	--	--	.5	02	--	--
Dryas drummondii	50	25	80	75	10	20	50	30
Dryas integrifolia	--	10	--	--	--	--	--	--
Epilobium latifolium	01	02	--	--	03	--	01	--
Fragaria virginiana	--	--	--	--	.5	03	.5	--
Habenaria hyperborea	--	01	--	--	--	--	--	--
Oxytropis campestris	--	--	--	--	.5	07	--	--
Parnassia parviflora	--	.5	--	--	--	--	--	--
Picea glauca	--	--	--	--	.5	--	.5	.5
Poa spp.	--	--	--	--	.5	05	02	--
Potentilla fruticosa	--	02	--	--	--	07	01	.5
Primula mistassinica	--	.5	--	--	01	--	--	--
Saxifraga aizoides	--	02	--	--	--	--	--	--
Senecio cymbalarioides	--	.5	--	--	.5	--	--	--
Solidago multiradiata	--	.5	--	--	01	--	--	--
Tofieldia glutinosa	--	03	--	--	--	--	--	--
BRYOID LAYER								
Bryum spp.	.5	.5	--	--	--	05	.5	--
Campylium stellatum	--	01	--	--	.5	--	--	--
Catoscopium nigritum	--	10	--	--	--	--	--	--
Ceratodon purpureus	.5	--	--	.5	.5	--	.5	--
Distichium inclinatum	--	01	--	--	--	--	--	--
Ditrichum flexicaule	--	--	--	--	.5	05	--	--
Drepanocladus uncinatus	03	--	.5	.5	--	--	--	--
Tortella spp.	.5	--	--	--	.5	--	--	05
Tortula norvegica	01	--	--	.5	--	--	--	--
Tortula ruralis	--	--	.5	--	--	--	--	--
Preissia quadrata	--	01	--	--	.5	--	--	--

virginiana (≤1-3%) are also prominent. *Campanula rotundifolia*, *Oxytropis campestris*, *Picea glauca* and *Epilobium latifolium* occur frequently but with low cover. Bryoid layer cover is usually <1% with unvegetated rock and mineral soil comprising 60 to 75% of the ground surface. H8 is early successionally. It is distinguished from other v.t.s by the dominance of *Dryas drummondii* and occurrence on recently deposited fluvial terraces.

Other Studies: H8 is also described in BNP and JNP (Corns and Achuff 1982) and in MRNP and GNP (Achuff and Dudynsky 1984). In British Columbia, Kuchar (1978, yellow dryad) in Yoho National Park and Raup (1934, *Dryas drummondii*) in northeastern British Columbia describe comparable types. Heusser (1956) describes a similar type in BNP and JNP. To the north in the Yukon Territory, Douglas (1974, *Dryas drummondii*) in Kluane National Park and Orloci and Stanek (1979, *Dryas drummondii*) describe similar types, and Kershaw (1981, *Dryas drummondii*) has a similar type in Nahanni National Park, N.W.T.

H11: *Carex aquatilis-Carex rostrata*

(water sedge-beaked sedge)

Environment: H11 fens occur on subhydric to hydric, Montane sites (1140-1300 m) in the Kootenay and lower Vermilion river valleys. Soils are poorly to very poorly drained Rego Gleysols and Organics on nearly level fluvial and morainal landforms.

Table 66. Stands of the water sedge-beaked sedge (H11) v.t. Values are percent cover.

	AW	JD	JD	KS	PA	PA	HD
	70	60	80	60	71	81	10
	98	39	26	53	34	00	25
HERB-DWARF SHRUB LAYER							
Betula glandulosa	--	05	.5	--	--	05	--
Carex aquatilis	80	38	80	50	70	80	50
Carex capillaris	--	--	01	--	--	--	--
Carex rostrata	--	42	.5	10	--	--	--
Deschampsia caespitosa	--	03	.5	--	--	05	--
Equisetum ssp.	.5	--	--	22	--	--	--
Erigeron peregrinus	--	03	--	--	--	--	--
Eriophorum angustifolium	--	--	--	--	01	--	--
Eriophorum scheuchzeri	--	--	--	--	.5	--	--
Hierochloe odorata	--	02	--	--	--	--	--
Pedicularis groenlandica	--	--	.5	--	03	--	--
Petasites sagittatus	--	01	--	06	--	--	--
Polygonum spp.	--	--	.5	--	--	--	03
Potentilla diversifolia	--	.5	--	--	.5	--	--
Rubus acaulis	--	04	--	--	--	--	--
Salix barrattiana	--	02	02	--	--	--	--
Salix brachycarpa	--	--	05	--	--	--	--
Salix nivalis	--	--	--	--	--	05	--
Valeriana sitchensis	--	.5	--	--	--	--	--
BRYOID LAYER							
Aulacomnium palustre	--	10	--	--	05	40	--
Bryum pseudotriquetrum	05	02	10	--	.5	--	.5
Calliergon giganteum	.5	--	.5	.5	--	--	--
Campylium stellatum	--	--	50	15	.5	10	--
Cinclidium stygium	.5	--	.5	--	--	--	--
Drepanocladus revolvens	85	--	.5	60	10	.5	10
Drepanocladus uncinatus	--	50	--	--	--	--	--
Meesia triquetra	02	--	.5	--	--	--	--
Myurella julacea	--	--	20	--	--	--	--
Philonotis fontana var.fontana	--	--	.5	--	01	--	--
Scorpidium spp.	--	--	--	--	.5	--	05
Tomenthypnum nitens	06	--	--	--	30	30	--

Vegetation: Total herb-dwarf shrub layer cover is 50 to 80% (Table 66) and strongly dominated by *Carex aquatilis* (50-80%) and *Carex rostrata* (5-60%). H11 is species-poor; the cover of other species is variable and usually low. These include *Equisetum* spp., *Lemna minor* and *Utricularia* spp. Bryoid layer cover varies but is usually <50%. Common species include *Drepanocladus revolvens, Tomenthypnum nitens* and *Bryum pseudotriquetrum*.

H11 is successionally mature in that it appears to be stable over perhaps hundreds of years. Gradual peat accumulation may result in an increase in shrubs and trees over time. H11 is distinguished from other v.t.s by the dominance of *Carex aquatilis* and *Carex rostrata*.

Other Studies: H11 is also described in BNP and JNP (Corns and Achuff 1982) and in MRNP and GNP (Achuff and Dudynsky 1984). In British Columbia, Kuchar (1978, tall sedge meadow) in Yoho

National Park and Raup (1934, *Carex rostrata*) describe similar types. Similar vegetation is described in Alberta by Kuchar (1972, *Carex aquatilis* wet meadow) and Crack (1977, *Carex aquatilis*) both in JNP, by Lewis *et al.* (1928, *Carex aquatilis*) in northern Alberta, by Kondla (1978, *Carex aquatilis* wetland) in the Kananaskis area, and by Kuchar (1973, tall sedge meadow) in Waterton Lakes National Park. Orloci and Stanek (1979) also have a similar type (*Carex-Equisetum*) in the southern Yukon.

H12: Saxicolous lichen

(saxicolous lichen)

Environment: H12 occurs throughout KNP on subxeric to xeric Alpine sites (2400-2650 m) on various slopes and aspects, although often on ridge crests. Soils are Orthic Regosols or nonsoil on the Miscellaneous Landscapes Rockland (R), Colluvial Rubble (CR) and Talus (T).

Vegetation: H12 is very sparsely vegetated with total cover typically <20% (Table 67). Individual species usually have <1% cover. Common vascular plants include *Saxifraga oppositifolia*, *Silene acaulis*, *Erigeron aureus*, *Cerastium beeringianum*, *Erigeron compositus*, *Draba lonchocarpa*, *Arenaria rubella*, *Saxifraga caespitosa*, *Saussurea densa*, *Saxifraga bronchialis* and *Draba incerta*. Many have a low, cushion growth form. Important lichens are *Xanthoria elegans*, *Umbilicaria virginis*, *Umbilicaria hyperborea*, *Thamnolia subuliformis*, *Lecanora rupicola*, *Rhizocarpon geographicum*, *Cetraria tilesii*, *Acarospora chlorophana* and *Dactylina ramulosa*.

H12 is mature successionally in that its composition will be stable for at least the next 100 years. H12 is distinguished by very low plant cover, which is often dominated by lichens and by occurrence at high altitudes above most other vegetation.

Other Studies: H12 is also described in BNP and JNP (Corns and Achuff 1982) and in MRNP and GNP (Achuff and Dudynsky 1984). In British Columbia, Kuchar (1978, lichen tundra, boulder and rock tundra) in Yoho National Park and Raup (1934) describe similar types. In Alberta, similar types are described in JNP by Crack (1977, high altitude open vegetation), Hettinger (1975, rock and lichen), Hrapko and La Roi (1978, *Potentilla nivea-Silene acaulis*), Kuchar (1975, cushion-rosette, lichen tundra), and La Roi (1975, *Silene acaulis/Alectoria*) and in BNP by Beder (1967, ridge summit type). Elsewhere in Alberta, comparable types are described by Ogilvie (1976, Kirby and Ogilvie 1969; stonefield-lichen), Jacques and Legge (1974, bare rock-lichen), Bryant and Scheinberg (1970), Kuchar (1973, saxicolous lichen tundra), and Kondla (1978, lichen dominated type).

H16: *Erigeron peregrinus-Valeriana sitchensis*

(fleabane-valerian)

Environment: H16 occurs throughout KNP on mesic to subhygric, Upper Subalpine (2000-2400 m) sites on mostly southerly, gentle to moderate slopes. The soils are well to moderately well drained Eutric and Dystric Brunisols on colluvial and morainal landforms.

Vegetation: H16 is a species-rich herb meadow (Plate 52) with a total herb-dwarf shrub layer cover of 60 to 90% (Table 68). *Valeriana sitchensis* (10-25%), *Anemone occidentalis* (10-25%), *Erigeron peregrinus* (5-20%), *Antennaria lanata* (5-20%) and *Senecio triangularis* (10-20%) are dominant. Other important species include *Ranunculus eschscholtzii* (1-5%), *Sibbaldia procumbens* (1-3%), *Vaccinium scoparium* (2-10%) and *Veronica alpina* (<1%). Bryoid layer cover is variable but usually <15% with *Tortula norvegica* and *Polytrichum juniperinum* most common.

H16 is mature successionally. It has many species in common with L7. However, L7 is dominated by *Salix arctica* and characteristic H16 species, such as *Valeriana sitchensis* and *Anemone occidentalis*, are absent or with low cover in L7.

Other Studies: H16 is also described in BNP and JNP (Corns and Achuff 1982) and in MRNP and GNP (Achuff and Dudynsky 1984). Similar types are described in British Columbia by Kuchar (1978, moist forb meadow) in Yoho National Park, Knapik and Landals (1974, *Valeriana*

Table 67. Stands of the saxicolous lichen (H12) v.t. Values are percent cover.

	JE 81 17	JE 90 21	JE 91 52	PA 70 21	PA 80 08 .1	PA 80 66 .2	PA 10 05 .1	PA 20 22 .1	PA 20 22 .4	PA 20 29 .1
HERB-DWARF SHRUB LAYER										
Arenaria spp.	--	--	--	--	--	.5	.5	--	--	--
Carex spp.	--	.5	.5	01	--	--	--	--	--	--
Cerastium beeringianum	--	--	--	--	--	.5	--	--	.5	.5
Draba incerta	--	--	--	.5	.5	--	.5	--	.5	--
Draba paysoni	--	--	--	--	--	.5	--	.5	--	--
Draba spp.	--	--	--	--	.5	--	.5	.5	.5	--
Erigeron aureus	--	--	--	--	--	--	.5	.5	.5	.5
Erigeron compositus	--	--	--	--	--	--	.5	--	.5	--
Erigeron humilus	--	--	.5	--	--	--	--	--	--	--
Luzula spicata	--	--	--	--	--	--	--	--	--	03
Papaver kluanensis	--	--	--	--	--	.5	--	--	--	--
Potentilla nivea	--	--	--	--	--	03	.5	--	--	.5
Salix nivalis	--	--	.5	02	--	--	--	--	--	--
Saussurea densa	--	--	--	.5	--	--	--	--	.5	.5
Saxifraga bronchialis	--	--	--	--	.5	--	.5	.5	--	--
Saxifraga caespitosa	--	--	--	--	.5	--	--	--	.5	--
Saxifraga oppositifolia	--	.5	--	01	--	.5	.5	.5	--	.5
Saxifraga spp.	--	--	.5	--	.5	.5	.5	--	--	.5
Sedum stenopetalum	--	--	--	.5	--	--	--	--	--	--
Senecio fremontii	--	--	--	--	--	--	--	--	.5	--
Silene acaulis	--	.5	01	.5	--	--	--	.5	--	.5
Selaginella densa	--	--	.5	.5	--	--	--	--	--	--
BRYOID LAYER										
Acarospora spp.	--	--	--	--	.5	.5	--	.5	--	.5
Aspicilia caesiocinerea	02	--	03	--	--	--	--	--	--	--
Aspicilia calcarea	06	--	.5	--	--	--	--	--	--	--
Bryum sp.	--	--	.5	.5	--	--	--	--	--	--
Caloplaca elegans	--	--	--	--	.5	--	--	.5	.5	.5
Cetraria ericetorum	.5	.5	--	--	--	--	.5	--	--	.5
Cetraria nivalis	--	.5	--	.5	--	--	.5	--	--	.5
Cetraria tilesii	.6	03	--	01	--	--	--	--	--	--
Cladonia pyxidata	--	--	01	.5	--	--	--	--	--	--
Coelocaulon aculeatum	--	.5	--	.5	--	--	--	--	--	--
Dactylina ramulosa	.5	.5	--	.5	--	--	--	.5	--	--
Ditrichum flexicaule	--	.5	.5	.5	--	--	--	--	--	--
Grimmia sp.	.5	--	.5	--	--	--	--	--	--	--
Hypnum revolutum	.5	.5	.5	.5	--	--	--	--	--	--
Lecanora spp.	05	.5	.5	--	.5	--	--	.5	.5	--
Lecidea spp.	03	.5	.5	--	.5	.5	--	--	.5	.5
Omphalodiscus virginis	05	--	03	--	--	--	--	--	--	--
Physconia muscigena	--	01	--	.5	--	--	--	--	--	--
Rhizocarpon geographicum	03	--	08	--	.5	--	.5	.5	.5	--
Sporastatia testudinea	.5	--	.5	--	--	.5	--	--	--	.5
Thamnolia subuliformis	--	.5	--	.5	--	--	--	.5	.5	--
Umbilicaria spp.	02	--	01	--	--	--	.5	.5	.5	.5
Xanthoria elegans	04	--	.5	--	--	--	--	--	--	--

sitchensis-Luzula glabrata) in MRNP, and Eady (1971, *Valeriana sitchensis-Castilleja elmeri*) in central British Columbia. In Alberta, similar types are noted in JNP by Kuchar (1975, *Artemisia norvegica/Salix arctica*) and La Roi (1975, *Artemisia norvegica/Cassiope mertensiana/Orthocaulis floerkii*) and in BNP by Broad (1973, *Anemone occidentalis-Thalictrum occidentale*) and Trottier and

Table 68. Stands of the fleabane-valerian (H16) v.t. Values are percent cover.

	HD	MF	MF	MF	PA	SD
	21	20	20	21	20	20
	24	86	99	05	23	58
	HERB-DWARF SHRUB LAYER					
Anemone drummondii	--	--	--	--	01	03
Anemone occidentalis	25	10	10	25	--	05
Antennaria lanata	20	--	03	15	10	02
Arabis lyallii	--	--	--	--	.5	.5
Arnica latifolia	.5	--	--	--	05	--
Carex nigricans	--	--	.5	04	--	.5
Carex scirpoidea	--	--	14	--	--	10
Carex spectabilis	--	07	--	--	--	.5
Cassiope mertensiana	.5	--	--	--	--	01
Castilleja miniata	--	02	--	--	--	.5
Claytonia lanceolata	--	--	--	--	01	05
Epilobium alpinum	--	.5	--	--	--	.5
Epilobium angustifolium	--	12	--	--	--	.5
Erigeron peregrinus	05	--	01	08	20	--
Fragaria virginiana	--	03	--	--	02	.5
Juncus drummondii	--	--	02	--	.5	.5
Luzula glabrata	--	--	.5	--	05	--
Parnassia fimbriata	--	01	--	--	--	.5
Pedicularis bracteosa	01	--	--	04	--	--
Phleum alpinum	.5	--	--	.5	--	--
Phyllodoce empetriformis	.5	--	--	--	.5	03
Phyllodoce glanduliflora	--	--	--	02	--	02
Phyllodoce intermedia	--	--	--	.5	.5	--
Potentilla diversifolia	--	--	--	--	03	01
Ranunculus eschscholtzii	.5	01	02	--	05	03
Salix arctica	--	--	--	--	--	05
Senecio triangularis	.5	08	34	--	15	20
Sibbaldia procumbens	01	--	03	.5	--	05
Trollius albiflorus	01	--	--	--	--	--
Vaccinium scoparium	--	02	05	10	15	.5
Valeriana sitchensis	03	25	10	15	--	15
Veratrum eschscholtzii	--	04	01	--	--	--
Veronica alpina	.5	.5	--	.5	--	.5
	BRYOID LAYER					
Polytrichum juniperinum	10	--	--	--	01	01
Polytrichum piliferum	--	--	--	10	01	--
Pseudoleskea radicosa var. compacta	10	--	--	--	--	--
Tortella tortuosa	05	--	--	--	--	.5
Tortula norvegica	--	08	01	--	02	01
Cetraria subalpina	20	--	--	--	--	--
Cladonia ecmocyna	.5	--	--	02	--	--
Peltigera malacea	05	--	--	01	--	--

Scotter (1973, ***Senecio triangularis-Caltha leptosepala-Trollius albiflorus-Erigeron peregrinus, Anemone occidentalis-Valeriana sitchensis-Veratrum eschscholtzii***). Jacques and Legge (1974, meadow rue), Trottier (1972, ***Thalictrum occidentale***), and Kuchar (1973, moist forb meadow) describe similar types elsewhere in Alberta.

H17: *Antennaria lanata-Vaccinium scoparium*

(everlasting-grouseberry)

Environment: H17 occurs in mesic, Upper Subalpine to Alpine (2200-2440 m) sites on southerly and westerly, moderate to steep slopes west of the Vermilion and Kootenay river valleys. The soils are well drained Sombric, Dystric and Eutric Brunisols on colluvial and morainal landforms.

Table 69. Stands of the everlasting-grouseberry (H17) v.t. Values are percent cover.

	HD	HD	HD	HD	HD	HD	JD	MF	SD	SD
	10	20	20	20	20	21	10	21	20	20
	31	81	82	85	86	07	22	48	60	64
HERB-DWARF SHRUB LAYER										
Anemone occidentalis	04	.5	.5	10	01	--	--	--	10	20
Antennaria lanata	35	05	20	50	20	30	30	23	35	30
Arnica latifolia	--	05	02	--	01	05	--	--	--	--
Carex nigricans	--	--	.5	--	--	--	--	--	25	--
Carex scirpoidea	--	15	--	20	--	--	--	04	--	05
Claytonia lanceolata	--	--	.5	--	.5	--	--	--	05	15
Erigeron aureus	--	--	--	--	--	.5	--	01	--	--
Erigeron peregrinus	--	30	10	--	20	03	--	--	.5	.5
Luzula spp.	.5	03	.5	--	03	.5	.5	--	10	.5
Phleum alpinum	--	--	--	.5	--	.5	02	04	--	--
Phyllodoce empetriformis	--	--	--	01	--	03	--	--	--	03
Phyllodoce glanduliflora	01	.5	05	--	--	04	--	--	05	03
Poa alpina	01	03	--	--	03	05	02	--	--	.5
Potentilla diversifolia	--	--	--	.5	.5	.5	02	03	--	--
Ranunculus eschscholtzii	--	--	.5	.5	--	.5	.5	02	03	.5
Salix arctica	01	--	--	05	--	--	01	--	--	.5
Salix nivalis	--	--	--	.5	--	--	--	--	.5	.5
Senecio lugens	--	--	--	--	01	--	--	--	.5	.5
Senecio triangularis	--	--	.5	--	--	--	--	--	--	03
Sibbaldia procumbens	03	--	.5	01	.5	.5	02	.5	03	--
Vaccinium scoparium	35	35	25	10	25	35	15	11	--	--
Valeriana sitchensis	.5	--	--	--	02	.5	01	--	--	10
Veronica alpina	--	--	--	.5	.5	.5	03	.5	.5	.5
BRYOID LAYER										
Pogonatum alpinum	.5	--	--	--	--	--	--	--	02	--
Polytrichum juniperinum	--	--	10	15	--	60	30	08	--	--
Tortula norvegica	--	--	--	--	45	--	35	--	--	--
Brachythecium spp.	.5	--	--	20	--	--	02	01	--	--
Barbilophozia lycopodioides	--	--	50	40	--	--	--	--	--	--
Cetraria islandica	.5	--	05	--	--	--	01	01	--	--
Cladonia ecmocyna	--	--	03	05	--	--	--	--	.5	--
Peltigera rufescens	.5	--	--	--	--	--	01	.5	.5	--

Vegetation: The herb-dwarf shrub layer has total cover of 75 to 100% (Table 69, Plate 10) with *Antennaria lanata* (20-35%) and *Vaccinium scoparium* (10-35%) dominant. Other characteristic species include *Anemone occidentalis* (<1-10%), *Ranunculus eschscholtzii* (1-3%), *Sibbaldia procumbens* (1-3%) and *Phyllodoce glanduliflora* (1-5%). Common species with low cover are *Veronica alpina*, *Valeriana sitchensis*, *Phleum alpinum*, *Claytonia lanceolata*, *Erigeron peregrinus* and *Potentilla diversifolia*. Bryoid layer cover is variable (15-80%) with *Polytrichum juniperinum* (10-30%) often dominant. *Pogonatum alpinum*, *Cetraria islandica* and *Peltigera* spp. are also common.

H17 is mature successionally. Snow avalanches and late snow melt appear influential in this v.t. H17 is differentiated from other v.t.s by the dominance of *Antennaria lanata* and *Vaccinium scoparium*.

Other Studies: Eady (1971, *Antennaria lanata* and *Antennaria lanata-Sibbaldia procumbens*) describes similar types in central British Columbia.

H19: *Agropyron spicatum-Elymus innovatus-Aster conspicuus*

(bluebunch wheatgrass-hairy wild rye-showy aster)

Environment: H19 grasslands occur on subxeric Montane (1000-1160 m) sites with various slopes and southerly aspects (Plate 68). Soils are rapidly drained Orthic Regosols on colluvial and glacial landforms. Only two stands of H19 were found in KNP; one at the mouth of Daer Creek and the other above the Radium Golf Course in extreme southwestern KNP.

Table 70. Stands of the bluebunch wheatgrass-hairy wild rye-showy aster (H19) v.t. Values are percent cover.

	KS	KS	KS	KS	MF	FA
	50	50	50	50	20	20
	04	06	07	08	01	10
SHRUB LAYER						
Juniperus communis	--	02	--	--	--	03
HERB-DWARF SHRUB LAYER						
Achillea millefolium	01	03	05	.5	02	.5
Agropyron spicatum	15	30	20	30	15	15
Allium cernuum	--	--	02	--	--	--
Antennaria nitida	.5	.5	02	.5	.5	01
Arabis holboellii	--	.5	--	--	.5	.5
Arctostaphylos uva-ursi	--	--	--	--	01	10
Artemisia frigida	01	04	--	15	03	--
Aster conspicuus	03	05	05	--	--	--
Astragalus spp.	--	--	.5	--	02	--
Balsamorhiza sagittata	--	--	--	--	02	.5
Carex xerantica	--	04	--	--	--	--
Cerastium arvense	.5	02	--	01	--	--
Chrysothamnus nauseosus	--	--	--	--	10	--
Cirsium hookerianum	.5	.5	--	--	--	--
Elymus innovatus	30	18	08	--	--	.5
Fragaria virginiana	--	02	--	--	--	--
Gaillardia aristata	--	--	--	--	01	--
Galium boreale	--	01	--	.5	03	--
Hedysarum sulphurescens	--	.5	--	--	--	--
Koeleria cristata	--	03	10	05	03	.5
Linum lewisii	--	--	--	--	.5	.5
Myosotis alpestris	01	02	--	--	--	--
Oxytropis splendens	08	02	.5	--	01	--
Penstemon confertus	--	05	.5	--	--	--
Poa spp.	08	--	--	--	05	--
Rosa acicularis	02	--	02	.5	--	--
Senecio canus	--	--	--	--	03	--
Stipa columbiana	--	--	15	--	--	--
Taraxacum officinale	--	--	.5	--	.5	01
Selaginella densa	--	.5	--	--	--	--
BRYOID LAYER						
Bryum caespiticum	--	--	--	--	01	15
Ceratodon purpureus	--	--	--	--	--	.5
Ditrichum flexicaule	--	--	--	--	--	.5
Tortella spp.	--	--	--	--	--	.5
Tortula ruralis	--	--	--	--	--	.5
Cladonia pyxidata	--	--	--	--	--	20
Peltigera rufescens	--	--	--	--	--	05

Vegetation: Shrub cover is low (<5%) consisting of scattered *Juniperus communis* and *Rosa acicularis* (Table 70). The herb-dwarf shrub layer (30-70%) is dominated by *Agropyron spicatum* (15-30%) and *Koeleria cristata* (3-10%). *Arctostaphylos uva-ursi* (1-10%) is also common. *Elymus innovatus* and *Aster conspicuus*, important in BNP H19 stands, are virtually absent in these stands. Commonly present with low cover are *Achillea millefolium*, *Antennaria nitida*, *Arabis holboellii*, *Linum lewisii* and *Taraxacum officinale*. Bryoid layer cover is low with bare soil cover often 40 to 50%. Common species are *Bryum caespiticium*, *Tortula ruralis* and *Cladonia pyxidata*.

H19 is successionally mature, the sites being too droughty and unstable for other vegetation. H19 is of limited extent both in KNP and in BNP, but it is similar to more extensive grasslands further south. It is distinguished from other grassland v.t.s by the dominance of *Agropyron spicatum*.

Other Studies: H19 is also described in BNP and JNP (Corns and Achuff 1982). No similar types are described by other authors in British Columbia. Mueggler and Stewart (1980, *Festuca scabrella-Agropyron spicatum*) describe a similar type in Montana.

H22: *Epilobium angustifolium-Thalictrum occidentale*

(fireweed-meadow rue)

Environment: H22 occurs on mesic Lower Subalpine to Upper Subalpine sites (1550-2250 m) throughout KNP on moderate to steep slopes of southerly aspect. Soils are well drained Humic Regosols developed on colluvial landforms. The sites are commonly snow avalanched.

Vegetation: Total cover of the herb-dwarf shrub layer is 95 to 100% (Table 71). *Epilobium angustifolium* (3-15%) and *Thalictrum occidentale* (10-50%) are dominant and *Fragaria virginiana* (1-5%) and *Achillea millefolium* (1-3%) occur frequently. H22 is very species-rich although most species have low cover. Other species include *Galium triflorum*, *Heracleum lanatum*, *Hedysarum sulphurescens*, *Rubus strigosus*, *Symphoricarpos albus* and *Vaccinium scoparium*. Bryoid layer cover is variable. Typical species include *Pohlia* spp., *Polytrichum juniperinum*, *Pleurozium schreberi* and *Bryum* spp. Scattered shrubs (*e.g.* *Acer glabrum*, *Amelanchier alnifolia*, *Shepherdia canadensis* and *Sambucus pubens*) with ≤2% cover occur in some stands.

H22 is mature successionally, being maintained by periodic snow avalanching. The dominance of *Epilobium angustifolium* separates H22 from other v.t.s. It differs from S5, which also contains much *Epilobium angustifolium*, by the greater amount of *Pinus contorta* and fire origin of the latter.

Other Studies: No similar types are described by other authors.

SUCCESSION AND CLIMAX

INTRODUCTION

Succession deals with directional changes over time in a plant community. Scientific thought on vegetational succession is currently in a period of flux. Most ecologists realize that the monoclimax paradigm of Clements (1916, 1936), while a valuable starting point, is now inadequate. For example, the Clementsian approach assumes that following disturbance a community regenerates itself to a climax stage through an orderly, predictable sequence of successional communities. This deterministic, single-pathway model fails to take into account, among other things, disturbance periodicity. Successional pathways may differ greatly if the time between disturbances is either very short or very long (Noble and Slatyer 1977, Cattelino *et al.* 1979). The *polyclimax* modification of Clements' ideas (Tansley 1935) helped some but still is not fully satisfactory. New ideas and ways of looking at succession recently have been put forward and are being tested and debated by ecologists (Botkin *et al.* 1972, Noble and Slatyer 1978, 1980). None seems presently suitable for this study so, while fully aware of its shortcomings, we have used a basically Clementsian scheme here. Another comparative shortcoming is that the ecological land classification focused primarily on mapping landscapes and the

Table 71. Stands of the fireweed-meadow rue (H22) v.t. Values are percent cover.

	HD	SD	SD	SD
	20	20	20	20
	52	24	27	35
HERB-DWARF SHRUB LAYER				
Achillea millefolium	01	03	--	.5
Agoseris aurantiaca	--	.5	--	--
Allium cernuum	--	03	--	--
Amelanchier alnifolia	--	01	--	--
Androsace septentrionalis	--	--	--	.5
Anemone drummondii	.5	--	--	--
Anemone occidentalis	--	--	--	03
Antennaria pulcherrima	.5	--	--	--
Arnica cordifolia	05	--	--	--
Aster conspicuus	--	10	--	--
Bromus marginatus	--	--	02	--
Carex festivella	--	--	02	--
Carex scirpoidea	--	--	--	05
Claytonia lanceolata	--	--	--	.5
Epilobium angustifolium	15	15	15	03
Erigeron peregrinus	--	--	--	.5
Fragaria virginiana	.5	05	05	.5
Galium triflorum	--	01	05	--
Geranium richardsonii	--	--	01	--
Hedysarum sulphurescens	04	--	--	.5
Heracleum lanatum	--	03	50	--
Myosotis alpestris	--	--	--	.5
Potentilla diversifolia	.5	--	--	.5
Pyrola virens	--	03	--	--
Ranunculus eschscholtzii	--	--	.5	.5
Rosa acicularis	--	10	--	--
Rubus parviflorus	--	10	--	--
Rubus strigosus	--	02	.5	--
Senecio lugens	.5	--	--	--
Smilacina racemosa	--	03	--	--
Smilacina stellata	--	05	--	--
Spiraea lucida	--	03	--	--
Symphoricarpos albus	--	05	05	--
Thalictrum occidentale	--	10	10	50
Vaccinium ovalifolium	--	05	--	--
Vaccinium scoparium	65	--	--	20
Veratrum eschscholtzii	.5	--	--	--
Veronica alpina	--	--	--	10
Zygadenus elegans	.5	--	--	--
BRYOID LAYER				
Desmatodon latifolius	--	--	--	01
Pleurozium schreberi	--	03	--	--
Polytrichum juniperinum	20	--	--	--
Pseudoleskea radicosa var. compacta	--	--	--	02
Bryum spp.	--	--	--	02
Pohlia spp.	40	--	--	.5

overriding objective of the vegetation component became a vegetation classification for the landscape classification scheme. Thus, succession was not a primary concern nor was it assessed directly. The information is only that obtained incidentally to the mapping program and permits only the description of generalized successional trends. Prediction of successional change for any specific area will require more detailed examination.

Succession is of two basic types. *Primary* succession occurs on sites without previous vegetation, such as newly deposited fluvial or morainal material. The time for primary successions to reach putative climax status is on the order of 500 to >1000 years. *Secondary* succession occurs where previous vegetation has been at least partially removed by a disturbance and generally requires <500 years to reach climax. Both types occur in KNP, with secondary succession being most prevalent. For the most part, the successional stages described for v.t.s in this report refer to the stage in secondary succession. Those few referring to primary successional stages are so labelled.

Fire is the predominant disturbance causing secondary succession in KNP. The Vermilion Pass burn of 1968 (Dubé 1976) was the most recent large fire (Munro and Cowan 1944). Fires are more frequent and influential at low elevations where the climate is drier and fuel accumulation more rapid. No fire history has been compiled for KNP and fire return intervals are not known. However, incomplete data from this study and Munro and Cowan (1944) indicate that major fires occurred in the Kootenay Valley about 1926, 1917, 1870, 1820 and 1800. Many C11, C19, C38 and C39 v.t. stands originated following the 1926 and 1917 fires. A better understanding of fire history and effects is key to dealing with the dynamics of vegetational succession in KNP.

Another important disturbance is caused by insect infestations, particularly mountain pine beetle (*Dendroctonus ponderosae*), which periodically kill large numbers of *Pinus contorta* trees (Moody and Cerezke 1983). Outbreaks have occurred episodically over at least the past 50 years in KNP (Hopping *et al.* 1939). An earlier outbreak from about 1930 to 1941 (Hopping 1941, 1951) killed many *Pinus contorta* trees in the Kootenay Valley, resulting in increased growth of remaining trees and invasion by *Pseudotsuga menziesii* and *Picea glauca* or *Picea engelmannii* as noted in this study and by Cerezke (1983). This suggests that such insect-caused mortality accelerates normal post-fire succession from *Pinus contorta* forests to ones dominated by *Pseudotsuga menziesii* or *Picea* spp. Other fire-insect interactions are also suggested in that beetle-killed trees increase fuel loadings greatly (*e.g.* much of the east side of the Kootenay Valley from Pitts Creek to Mount Shanks), thus likely influencing fire ignition and severity, both of which directly affect vegetational succession. The current mountain pine beetle outbreak which began about 1977 (Cerezke 1983) will again influence succession in much of KNP in ways unknown at present.

Since KNP is predominantly forested, the successional roles of the tree species are basic to understanding successional dynamics. On this basis, tree species are either *successional* or *climax*. *Pinus contorta* is the most prevalent successional species, dominating large portions of KNP after fire. In some stands of the lodgepole pine/juniper/bearberry (C3) v.t. where the regeneration is mostly *Pinus contorta*, *Pinus contorta* can be considered a climax species. But this it not widespread. *Larix occidentalis* is also a successional, post-fire species. *Populus tremuloides*, *Populus trichocarpa* and *Betula papyrifera* are considered successional species although their role is less clear. The rest of the trees in KNP (*Pseudotsuga menziesii*, *Picea glauca*, *Picea engelmannii*, *Abies lasiocarpa*, *Pinus albicaulis* and *Larix lyallii*) are climax species. In the Upper Subalpine where *Pinus contorta* is largely absent, some of these species may establish on a site immediately after disturbance. The difference between successional and climax roles becomes indistinct in such situations. Also, *Pseudotsuga menziesii* appears to play a successional role on some Lower Subalpine sites.

A four stage successional sequence is used to classify v.t.s in this report: *early*, *intermediate*, *advanced* and *mature* (climax). The early successional stage is usually heterogeneous and unstable in composition, often not referable to a v.t. and usually <50 years old since major disturbance or origin. The intermediate successional stage is moderately stable, more uniform in composition and dominated by species not climax for the site. Commonly, *Pinus contorta* dominates but *Pseudotsuga menziesii* or *Picea* spp. and *Abies lasiocarpa* regeneration in the understory indicates an eventual dominance by the climax species. Successionally intermediate forest communities are generally 50 to 100 years old, although considerable variation occurs. The advanced successional stage is generally 80 to 200 years old and dominated by a mixture of successional and climax species. In forested v.t.s, this is most typically a mixture of *Pinus contorta* (successional) and *Picea* spp. and *Abies lasiocarpa* (climax). The duration of this stage varies but 40 to 50 years is typical. The mature (climax) stage is compositionally stable, self-perpetuating and the end point of vegetational succession. In KNP, it generally takes 100 to 300 years to reach this stage by secondary succession after fire in forest communities. The successional stage of each v.t. is indicated in the v.t. description.

MONTANE ECOREGION

In the Montane Ecoregion, mature forests are generally dominated by ***Pseudotsuga menziesii*** and ***Picea glauca***, ***e.g.*** the Douglas fir/hairy wild rye (C1), white spruce-Douglas fir/feathermoss (C5) and Douglas fir/juniper/bearberry (O5) v.t.s. These have often developed from ***Pinus contorta*** forests, such as lodgepole pine/juniper/bearberry (C3), lodgepole pine/buffaloberry/twinflower (C19), lodgepole pine/buffaloberry/pine grass (C38) and lodgepole pine/buffaloberry/bunchberry (C39). On the driest Montane sites, grasslands form the mature vegetation with v.t.s such as bluebunch wheatgrass-hairy wild rye-showy aster (H19). Fire also may be important in maintaining these grasslands and return to a climax composition after fire may take 10 years or less.

SUBALPINE ECOREGION

Mature forests in the Subalpine Ecoregion are dominated mainly by ***Picea engelmannii*** and ***Abies lasiocarpa***, ***e.g.*** the Engelmann spruce-subalpine fir/false azalea (C14), Engelmann spruce-subalpine fir/grouseberry (C15) and Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) v.t.s, which have often developed from ***Pinus contorta*** forests, such as lodgepole pine/feathermoss (C11), lodgepole pine/buffaloberry/grouseberry (C18) and lodgepole pine/false azalea/grouseberry (C20). In the Upper Subalpine, ***Larix lyallii*** and ***Pinus albicaulis*** are more prominent with, ***e.g.*** the subalpine larch-subalpine fir/grouseberry-everlasting (C23), subalpine larch-subalpine fir/heather (O13) and Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4) v.t.s, and ***Pinus contorta*** is virtually absent. Forest succession is slower in the Upper Subalpine, often requiring >300 years to reach a mature stage. A number of shrub and herb dominated v.t.s appears to be compositionally stable (*e.g.* subalpine fir-willow (S2), green alder/fern (S13), hairy wild rye-wild strawberry-fireweed (H5) and fleabane-valerian (H16)) and in equilibrium with environmental factors such as snow avalanching or dry, exposed sites. Since they appear stable under present conditions, they are considered mature.

ALPINE ECOREGION

Succession in the treeless Alpine Ecoregion is more difficult to document than in forests where trees provide easily obtained evidence of stand age. Fire is infrequent in the Alpine and water erosion and cryogenic processes are the main agents of disturbance which initiate secondary succession. Succession is very slow and recovery, for example after trampling, may take hundreds of years (Willard and Marr 1970, 1971). All v.t.s in the Alpine are considered climax since they appear stable over several hundred years. Some, such as saxicolous lichen (H12), are at an earlier primary successional stage than others, but it is questionable whether substantial change will occur in H12 sites in the next few hundred years. Overall, succession is not a significant process in the Alpine Ecoregion.

WETLANDS

Succession in wetlands of all Ecoregions differs from that on uplands. Rates appear to be slower although the shrubby or herbaceous vegetation makes stand history determination difficult. Peat coring, needed to make an accurate assessment, was beyond the scope of this study. Since most wetlands appear stable over a 50 to 100 year period, they have been designated successionally mature. Landscape changes due to peat accumulation, stream aggradation and erosion, and cryoturbation are often coincident with vegetational change on these sites, thus confounding successional history determination.

SIGNIFICANT BOTANICAL FEATURES

RARE SPECIES

The following information on rare species is based on collections made during the ecological land classification, and collections in the KNP herbarium at Nipika. Rarity is derived from a list of rare plants of British Columbia (Taylor 1983). Four categories of rarity are used in that list and here also:

R1 - single or few populations
R2 - several populations, locally common
R3 - widespread or scattered distribution
R4 - restricted distribution, large populations.

This section deals only with vascular plants since insufficient information is available to make a similar evaluation for nonvascular plants. The following list of rare plants is alphabetical by genus and species.

Arabis lemmonii R3
Arabis nuttallii R2
Artemisia cana R1
Aster alpinus R4
Astragalus aboriginum R3
Astragalus bourgovii R?
Astragalus lotiflorus R3
Astragalus robbinsii var. *occidentalis* R4
Braya humilis R2
Calamagrostis montanensis R4
Carex eburnea R4
Carex microglochin R3
Carex sartwellii R3
Castilleja cervina R4
Castilleja occidentalis R3
Castilleja rhexifolia R3
Cheilanthes feei R3
Cypripedium montanum R3
Cypripedium passerinum R3
Cystopteris montana R3
Delphinium bicolor R2
Dodecatheon conjugens R4
Draba albertina R3
Draba borealis R3
Draba paysonii R3
Draba porsildii R1
Erigeron lanatus R3
Erigeron pallens R2
Epilobium glaberrimum R1
Festuca baffinensis R3
Gaultheria humifusa R3
Hackelia floribunda R3
Hedysarum sulphurescens R3
Helenium autumnale var. *grandiflorum* R2
Juncus parryi R3
Kobresia simpliciuscula R?
Ledum glandulosum R4

Lepidium ramosissimum R?
Lilium philadelphicum R4
Lonicera dioica R3
Lygodesmia juncea R2
Minuartia dawsonensis R3
Minuartia nuttallii R3
Muhlenbergia glomerata R3
Oryzopsis micrantha R3
Oxytropis podocarpa R2
Pedicularis contorta R2
Pellaea glabella R3
Penstemon eriantherus R4
Pinus flexilis R2
Potentilla hyparctica R3
Primula mistassinica R2
Pyrola elliptica R3
Ranunculus inamoenus R2
Ranunculus pedatifidus R1
Ranunculus pygmaeus R3
Ranunculus verecundus R3
Romanzoffia sitchensis R3
Salix vestita R3
Saussurea densa R4
Senecio congestus R1
Taraxacum lyratum R3
Vaccinium myrtillus R2
Viola nephrophylla R1

OTHER SIGNIFICANT BOTANICAL FEATURES

Geographic range boundaries which occur within the park are also a significant botanical feature. Populations near a range boundary are often small and presumably near an extreme of their environmental tolerance. These populations should receive special management consideration, including monitoring of range expansion or contraction and of population trend. Information needed to evaluate range boundaries of most plants in KNP is generally either insufficient or not readily accessible. However, information is sufficient for three tree species: *Larix occidentalis*, *Pinus ponderosa* and *Tsuga heterophylla*.

Larix occidentalis occurs as scattered individual trees and small groves in the Montane Ecoregion along Sinclair Creek to Sinclair Pass, along Swede Creek, and in the Kootenay Valley from the south boundary of the park along Settler's Road, north to about Kootenay Crossing. Several groves occur at the foot of Luxor Pass and a few trees occur about 1.5 km north of Kootenay Crossing. These populations form the northern limit of occurrence in this part of British Columbia. *Larix occidentalis* does not appear to occur in any other Canadian national park.

Pinus ponderosa occurs as scattered individual trees in the Montane Ecoregion in the Stoddart Creek area, south of the present park boundary but within the area of the proposed park extension (Plate 19). This population is apparently the farthest north *Pinus ponderosa* occurs in the Columbia Valley and forms the northeastern limit of occurrence in Canada. *Pinus ponderosa* also appears not to occur in any other Canadian national park.

Tsuga heterophylla occurs as a small grove of trees about 1.5 km up the Verdant Creek trail from Vermilion Crossing. This small population is close to the northeast limit for the species, although a few isolated trees have been found in BNP and JNP (Achuff and Corns 1982) to the northeast and small stands occur in a few localities in Yoho National Park (Kuchar 1978). *Tsuga heterophylla* is quite common west of KNP and is a major species in Mount Revelstoke and Glacier National Parks.

The southwestern corner of KNP, including the Stoddart Creek area, is markedly different from anywhere else in the park. The drier environment of the Rocky Mountain Trench results in conditions which more typically occur further south. This is the only area of KNP where the dry v.t.s Douglas fir-ponderosa pine/wheatgrass (O24) and bluebunch wheatgrass-hairy wild rye-showy aster (H19) occur. Species restricted to this area within KNP include: ***Pinus ponderosa*, *Artemisia cana*, *Chrysothamnus nauseosus*, *Castelleja cervina*, *Pellaea glabella*** and ***Calochortus macrocarpus***. The report of a cactus, probably ***Opuntia polyacantha***, in the area could not be confirmed but is not unlikely. Other significant species will likely be found with additional work in this area. Since the Stoddart Creek area is small and unusual compared to the rest of KNP, special management consideration is appropriate.

A final note of qualification. The fieldwork for this study was oriented to a land classification objective and, as such, focused on representative, extensive landscapes. Only limited collecting effort occurred in rare or unusual habitats which are more likely to contain rare or unusual species. Thus, this section and Appendix A should be regarded as a minimal account of the flora of KNP. A more thorough effort, devoted particularly to specialized habitats, will undoubtedly result in the discovery of additional species.

CHAPTER IV - WILDLIFE

D.M. Poll and M.M. Porter

INTRODUCTION

GENERAL DESCRIPTION OF WILDLIFE

One of the most spectacular and observable features of the fauna of KNP is the six species of ungulates. Their occurrence in the park is due to the variety of habitats and the protection afforded by the National Parks Act. Although most of the vegetated portion of the park is used by ungulates in summer, most species are severely restricted or forced to leave the park in winter due to high snow accumulations. Moose and mountain goat are year-round residents. Some elk and most mule deer move out of the park in winter, with those remaining restricted to Montane valley bottoms or steep southerly slopes in the Sinclair drainage. Most bighorn sheep winter on south and west aspects above the Columbia River outside the present park boundary. White-tailed deer leave the park entirely most winters, moving south into the Kootenay Valley or west to the Columbia Valley.

The variety of ungulates and small mammals sustains a wide diversity of carnivores. However, only coyotes and marten are widespread and common. Wolves have been historically rare in KNP, however during winter 1982-83 at least eight wolves wintered in the Kootenay Valley. Lynx are widespread but uncommon, while bobcats are very rare and confined to the southern portion of the Kootenay Valley. Cougars are rare, occurring mainly in the southwestern portions of the park. A wide variety of *Mustelidae* (weasels) occurs in the park, however only marten and short-tailed weasels are common. Long-tailed weasels are uncommon and mink are very rare. Fishers and otters are rare. Wolverines are widespread, but uncommon. Badgers and striped skunks are known only from lower Sinclair Creek and are very rare.

Black bears are common at low elevations in the Kootenay and lower Vermilion River valleys. Grizzlies are uncommon and occur generally at higher elevations, primarily in the upper Vermilion and upper Sinclair watersheds.

Thirty-two other species of mammals occur or have occurred in KNP. The four species of shrews are uncommon, and water and pigmy shrews are rare. Seven species of bats have been recorded. All are rare or uncommon. Lagomorphs are represented by pika and snowshoe hare. Pikas are relatively uncommon while snowshoe hares are widespread and common in closed coniferous forests from Montane to Upper Subalpine. The Order *Rodentia* contains the remaining 18 species, of which red-backed vole, deer mouse, red squirrel and Columbian ground squirrel are most common.

At least 191 species of birds occur in KNP. Of these, 32 are permanent residents of the park; the rest migrate each winter to areas where weather is less severe.

Bird densities are low at all seasons in the prevalent coniferous forest vegetation which provides little habitat stratification or forage. Nonetheless, there are limited areas with high species densities. These include wetlands and vegetation mosaics along Montane streams and lakeshores, the diverse mixed forest of the Kootenay Valley, and the bases of snow avalanche slopes.

Waterfowl and shorebirds are scarce during the breeding season, due to the scarcity of ponds and lakes. Although KNP is not on a major migration flyway, all of the ponds and lakes are used by migrants. In a park context, certain ponds and wetlands (*e.g.* Dog Lake, Daer Pond and Kootenay Ponds) are highly important to breeding and migratory birds due to their well developed shoreline vegetation.

Raptors and owls are less common in KNP than in the adjacent Columbia Valley. Most records are from Montane parts of the Kootenay and Columbia valleys. Mixed forests near McLeod Meadows and Dolly Varden Creek are important to Red-tailed Hawk, American Kestrel, Great Gray Owl, Northern Pygmy-Owl and Boreal Owl. Six species of owls probably breed in KNP, with Boreal Owl one of the commonest.

Among the more notable features of the avifauna are:

1. The first Great Gray Owl nest record for southeastern British Columbia, near Dolly Varden Creek.
2. Small breeding populations of Rock Wren, Dusky Flycatcher and Cassin's Finch in the dry southwest corner of the park.
3. Wintering populations of Townsend's Solitaire and Red-breasted Nuthatch also in the southwest corner of the park.
4. Black Swifts which occur at Marble Canyon and possibly breed there.

Four amphibian and three reptile species have been recorded in KNP. Wood frogs, spotted frogs and western toads breed in Montane and Lower Subalpine ponds. Long-toed salamanders are limited to Montane ponds of the Kootenay Valley. Three species of snake occur infrequently; the Sinclair Canyon area provides rocky bluffs where they are most often seen. Only the western toad ranges throughout the park at most elevations.

SAMPLING RATIONALE

Methods were chosen to collect data on the seasonal abundance, distribution, and habitat characteristics of all species of mammals, birds, amphibians, and reptiles that occur in KNP (Table 72). The broad scope of the inventory and the large area involved necessitated a variety of methods. Some were directed specifically at relating wildlife abundance to the ecological land classification. Others surveyed the seasonal movements of selected species, to determine the actual density of some species and to locate less common species. In addition to these primary methods, described below in detail, the wildlife inventory staff lived near KNP year-round and became familiar with the park and with long-time residents, ultimately developing insights and understanding which could not have been gained in any other way.

The wildlife inventory in KNP, unlike that in BNP and JNP, coincided with the landform-soils-vegetation inventory. This integration of field effort necessitated the modification and streamlining of particularly the ungulate sampling methods to be compatible in time and space with soil and vegetation sampling methods.

SYSTEMATIC SAMPLING OF ECOSITES

In order to assess the importance of 78 Ecosites to each of 242 wildlife species, sample techniques that were fast and simple, yet quantitative, were used. Because of the large area to be inventoried and the probability that wildlife use would vary on the same Ecosite from one part of the study area to another, it was necessary to be able to obtain several samples of each Ecosite in different parts of the park.

The major constraints on developing these techniques were:

1. Each sample had to fit within the boundaries of one mapped tract and one vegetation type (v.t.). The maximum area sampled was 500 m x 500 m.
2. Each method had to require a limited amount of time, effort and equipment, to allow a small staff to sample numerous sites over a wide area and in rugged terrain.

Table 72. Ecosite sampling methods and species groups sampled.

Sampling method	Species group							Sample size
	Ungulates	Carnivores	Hares	Squirrels	Small mammals	Breeding birds	Wintering birds	
Pellet group transects	•		•					928
Browse use plots	•		•					4240
Track count transects	•	•	•	•			•	315.4 km-days
Circular breeding bird plots				•		•		605
Snap traplines					•			10,000 trapnights
Random observations	•	•	•	•	•	•	•	——

3. Each method had to be standardized, easily taught to new staff, and based on the best techniques in published literature at the time the project was initiated.
4. Each method had to be quantitative so that indices of abundance could be compared between Ecosites.
5. Each method, where possible, had to be compatible with soil and vegetation sampling methods.

The methods which fulfilled these requirements were pellet group counts, browse use transects, track count transects, circular breeding bird census plots, and snap traplines (Table 72). These are described briefly below and in more detail in Vol. II (Poll *et al.* 1984). In addition, random observations by park and inventory staff were related directly to Ecosite importance in many cases. The selection of sample locations varied. Pellet group and browse use transects were conducted almost exclusively in conjunction with soil and vegetation sampling. These samples were located in homogeneous areas representative of the predominant soil and vegetation of the map polygon. Selection of sample locations for the other methods was more subjectively based on wildlife use. An attempt was made to sample as many Ecosite-v.t. combinations as possible in each season and major watershed. Ecosites were selected from the mapped air photos (scale of 1:63,360) provided by the land inventory team and chosen for sampling based on vegetation sample data, accessibility (primarily in winter), size of the tract, and proximity to other suitable Ecosites. Complete coverage of all Ecosites in all drainages was not possible due to extremely rugged terrain, dense, dead-fall laden forests and, in winter, extreme snow avalanche hazard in many valleys.

The major requirement for locating any sample was that it had to fall entirely within the boundaries of one tract and one v.t. In some complex tracts, such as heavily gullied slopes, alluvial or colluvial areas, where vegetation was heterogeneous, this was not possible and the sample was considered to have been collected in the most prevalent v.t. of that tract.

METHODS

FIELD SAMPLING

The relative importance of an Ecosite to each ungulate species was determined by pellet group counts. Pellet groups were counted along four 2 x 50 m transects spaced at 20 m intervals and centered around the 20 x 20 m vegetation and soil sample plot. The number of pellet groups of each species from each transect was multiplied by 100 to give pellet groups/ha and an average density was calculated for each Ecosite and v.t. On the same 50 m transects, the presence or absence of snowshoe hare pellets was determined in 1 m^2 plots spaced at 5 m intervals along each transect. An average hare pellet frequency value was calculated for each Ecosite and v.t. Ungulate and snowshoe hare use of woody browse plants was assessed using a method adapted from Cole (1959) for ungulate use and Pease *et al.* (1979) for snowshoe hare use. Shrubs were rated for ungulate and snowshoe hare use using a *nearest neighbor* selection method in 2.5 m diameter plots at 5 m intervals along two of the 50 m transects. The results were tallied for all transects within each Ecosite and v.t. This information was used to identify major browse species on each Ecosite and also in assigning importance rankings to Ecosites for ungulates.

Relative abundance of small mammals on each Ecosite was determined using traplines of 100 *Woodstream Museum Special* traps baited for two nights. The number of rodents and shrews caught was averaged for each Ecosite. The averages were used in a cluster analysis to identify Small Mammal Associations, and to determine the density ranking for each Ecosite.

Winter mammal activity was assessed by counting the number of tracks intercepted by a straight transect of 0.5 km or longer. Track counts for each species were standardized to the number of tracks per km-day by dividing the total track count by the total distance of the transect times the number of days since the last snowfall. These figures were averaged for each Ecosite and v.t. Snow depths were measured on most transects. In addition, all birds seen or heard were recorded.

Breeding bird populations were sampled using a modification of the variable circular plot method (Reynolds *et al.* 1980). Sampling was conducted before 0900 h between June 1 and July 15. The number of birds recorded was corrected for detectibility (Emlen 1971, 1977) and density indices for each species were calculated for all circular plots in each Ecosite and v.t. Cluster analyses, based on species density and diversity in each v.t., were used to identify Breeding Bird Communities. These were then related to each Ecosite. Red squirrel, Columbian ground squirrel and pika densities were also assessed by this method.

ECOLOGICAL INTEGRATION

ABUNDANCE RATINGS

One of the objectives of the wildlife inventory is to determine the distribution of wildlife at a scale of 1:50,000. Plotting sightings or sign would not accomplish this goal but would show only the location of the observers when they found wildlife. An alternate approach is to identify important wildlife habitat and then map the habitats. The land classification provides the map base to show the distribution of habitat as long as the criteria used to identify Ecosites also define wildlife habitats. Most wildlife habitats can be related to one or more Ecosites. Some habitats are too small to be identified at a scale of 1:50,000; other habitats are complexes of Ecosites which are difficult to identify in a classification system. Consequently, there are difficulties relating some wildlife habitats to Ecosites. However, many habitats can be readily related to Ecosites, and the classification and mapping scheme can illustrate the distribution of these habitats.

Important wildlife habitats are identified by sampling wildlife or their sign on all Ecosites and v.t.s. For each sample type and species, the results on each Ecosite were ranked as described below and a legend prepared correlating wildlife importance rankings with each Ecosite.

These methods provide data on relative abundance but in numerical form they are difficult to use in comparing Ecosites. In addition, each method has a different range of numerical values. To simplify use of the data, they have been converted into rankings that allow easy comparison of Ecosites.

ECOSITE RANKINGS

Data from the primary sample methods were computer-manipulated to produce an average quantity for each Ecosite. The quantities for the Ecosites are then ranked as **none, low, moderate, high** and **very high** to compare the relative degree of use of each Ecosite. The ranking was determined by dividing non-zero values into three equal groups. Ecosites having values in the lowest one-third are of **low** importance. Those in the middle one-third are **moderately** important, and those in the upper third are **highly** important. The five or ten Ecosites having the highest values are **very highly** important.

Thus, the importance of an Ecosite to a species is derived directly from the measured relative abundance of that species on the Ecosite. For groups of species (*e.g.* Small Mammal Associations and Breeding Bird Communities) the total of rankings of all species is combined with the number of species to evaluate the importance of Ecosites.

Vegetation types were similarly ranked as to their importance to wildlife. *Important* habitats are Highly ranked Ecosites and v.t.s. *Critical* habitats are Very Highly ranked Ecosites and v.t.s, in addition to habitats with special functions for wildlife (*e.g.* denning, calving, staging). It should be borne in mind that **critical areas may be site-specific** and hence not predictable on the basis of habitat generalities. Assessment of the importance of a site to wildlife must be supported by field observations on that site.

This ranking of Ecosites assumes that all Ecosites were sampled equally, and that animals and their sign are equally detectable on each Ecosite. While these assumptions are true in many instances, they do not always apply. For example, in winter some moose use wetlands where their droppings end up in standing water the following spring, and are not detected in pellet group counts. All rankings were reviewed subjectively and some were adjusted because of sampling bias.

An additional method of ranking Ecosites was devised for lynx, coyotes, and cougars. Relatively few tracks of these species were recorded on track transects, yielding insufficient data to rank their occurrence on each Ecosite. There are, however, considerable data on the distribution of ungulates and other prey on each Ecosite. From studies of the food habits of coyotes (Bowen 1978), and cougars (Robinette *et al.* 1959), the proportion of each prey species in the predators' diet was determined and used as a weighting factor to determine the potential importance of each Ecosite to the predator (Table 73) For each Ecosite, the rank for each prey species was assigned a value (0 for none, 1 for low, 2 for medium, 3 for high and 4 for very high). The following formula was used to derive values:

> Ecosite value = (prey species' rank value) X (proportion of that species in the predator's diet) summed for all prey.

For lynx, Ecosite rankings of snowshoe hare were used because of the paucity of tracking data and the dependence of lynx on hare. These values were ranked similarly to the results from other sampling methods; the lowest third were **low**, the middle third **moderate**, the upper third **high** and the top five **very high**. For coyotes and lynx these ranks compared well to the limited track count information available.

For species which were poorly documented by these primary sampling methods (*e.g.* non-territorial birds in the breeding season; uncommon and wide ranging carnivores such as wolverines and cougars; and larger rodents such as beavers, porcupines, hoary marmots, and Columbian ground squirrels which were not sampled by snap trap methods), random observations were used to assign Ecosite rankings.

Table 73. Percentages of prey in the diets of coyote[1] and cougar[2].

Prey species	Coyote		Cougar
	winter	summer	
Snowshoe hare	7	1	0
Columbian ground squirrel	0	13	0
Microtine voles	16	11	0
Deer	26	22	29
Moose	6	2	0
Elk	30	25	17
Bighorn sheep	4	2	15

[1] Bowen 1978
[2] Robinette *et al.* 1959

In this volume, the importance of each Ecosite to wildlife is briefly discussed. Generally, only the species for which the Ecosite is highly or very highly important are identified. Factors that result in the importance rating, such as snow depth, forage abundance, and prey availability are discussed briefly. In addition, for ungulates and carnivores, a single rating of importance is presented for some Ecosites. This rating is derived from the sum of the individual species ratings. It is not intended to be used for site specific planning or management but for planning at the park level or larger.

SMALL MAMMAL ASSOCIATIONS

A *Small Mammal Association* (SMA) is a group of insectivores and small rodents that often occur together due to similar habitat preferences. The 11 species (red-backed vole, deer mouse, heather vole, meadow vole, long-tailed vole, dusky shrew, northern bog lemming, western jumping mouse, masked shrew, yellow-pine chipmunk, and least chipmunk) considered here are those sampled reliably by snap trapping.

The results of 50 snap trap lines and two live trap grids were pooled and grouped subjectively by similarities in habitat and species captured. An index of relative density (catch per 100 trap nights) was calculated for each species captured on each trap line and used to determine relative dominance within associations. Associations described from BNP and JNP (Holroyd and Van Tighem 1983) were carried over to KNP, where applicable. (*e.g.* SMA 1 of KNP equals SMA I of BNP and JNP). Slight differences in v.t. correlates for SMA's between KNP, and BNP and JNP are largely a result of east-west variation in moisture regimes as discussed below. In the following descriptions, ***definitive*** species are those which occur at high frequency within a group of v.t.s and are central to the SMA definition. ***Additional*** species are all other species trapped on those same trap lines. The frequency of occurrence (number trap lines with species/total trap lines within the SMA) and the average capture rate per 100 trap nights within an SMA appear after each species listed. All Ecosites were not sampled, therefore it was necessary to extrapolate to unsampled Ecosites based on similarities in Ecoregion, landform, and v.t.

SMALL MAMMAL ASSOCIATION 1

Deciduous forest, dry coniferous open forest, grassland and tundra

SMA 1 occurs on mesic to subxeric sites of predominantly southerly and westerly aspects from the Montane to the Alpine; most frequently in the Montane and Lower Subalpine. Soils are derived from morainal, fluvial, and colluvial materials. Vegetation reflects the relatively dry soil conditions and includes open and closed forest dominated by Douglas fir (***Pseudotsuga menziesii***), Engelmann spruce-subalpine fir, (***Picea engelmannii-Abies lasiocarpa***), poplar (***Populus*** spp.) or lodgepole pine (***Pinus contorta***) with grass understories (***Calamagrostis*** spp., ***Elymus*** spp., and ***Agropyron*** spp.), buffaloberry (*Shepherdia canadensis*), juniper (*Juniperus communis*), shrubby cinquefoil (*Potentilla fruticosa*), bearberry (*Arctostaphylos uva-ursi*), twinflower (*Linnaea borealis*), and *Aster* spp.; and grasslands dominated by wheatgrass (*Agropyron* spp.), june grass (*Koeleria cristata*) or mountain avens (*Dryas octopetala*) tundra.

Definitive Species	**freq.**	**dens.**		**freq.**	**dens.**
deer mouse	6/6	4.4			
Additional Species					
red-backed vole	1/6	0.3	long-tailed vole	1/6	0.3
yellow-pine chipmunk	1/6	0.06	dusky shrew	2/6	0.2

Remarks

This association is restricted to the driest habitats, occurring predominantly in southwestern KNP. Deer mice are clearly dominant in these dry forest and grassland communities. Capture rates averaged 4.7/100 trap nights in closed and open forests (C16, C22, O5, O24) and 3.5 in junegrass-pasture sage-wild blue flax (H6) grassland.

Vegetation Type correlates

aspen/hairy wild rye-peavine (C16)
balsam poplar/buffaloberry (C17) (Corns and Achuff 1982)
aspen/hairy wild rye-showy aster (C22)
lodgepole pine/juniper/bearberry (C3)
Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4)
Douglas fir/juniper/bearberry (O5)
aspen-dwarf birch/bearberry (S16)
arctic willow-cinquefoil (L7)
mountain avens-snow willow-moss campion (H1)
mountain avens-kobresia-bearberry (H4) (Corns and Achuff 1982)
junegrass-pasture sage-wild blue flax (H6) (Corns and Schuff 1982)
everlasting-grouseberry (H17)
wheatgrass-pasture sage (H7) (Corns and Achuff 1982)
bluebunch wheatgrass-hairy wild rye-showy aster (H19)

SMALL MAMMAL ASSOCIATION 2

Mesic pine-spruce-Douglas fir forest

SMA 2 occurs in moist, closed forests primarily in the Montane and Lower Subalpine Ecoregions. Soils are mesic, derived from morainal, colluvial, glaciofluvial or fluvial materials. Forest canopies include lodgepole pine (*Pinus contorta*), Douglas fir (*Pseudotsuga menziesii*), spruce (*Picea* spp.), poplar (*Populus* spp.), lodgepole pine (*Pinus contorta*), Engelmann spruce-subalpine fir (*Picea engelmannii-Abies lasiocarpa*) and western red cedar (*Thuja plicata*) with shrub/grass and shrub/moss understories. Common understory plants include buffaloberry (*Shepherdia canadensis*), false azalea (*Menziesia glabella*), grouseberry (*Vaccinium scoparium*), tall bilberry (*Vaccinium membranaceum*), bunchberry (*Cornus canadensis*), twinflower (*Linnaea borealis*), pine grass (*Calamagrostis rubescens*) and hairy wild rye (*Elymus innovatus*).

Definitive Species	freq.	dens.		freq.	dens.
red-backed vole	13/13	11.8	deer mouse	9/13	1.7

Additional Species

heather vole	2/13	0.2	long-tailed vole	2/13	0.1
northern bog lemming	1/13	0.1	meadow vole	1/13	0.07
dusky shrew	1/13	0.04	masked shrew	1/13	0.1
pygmy shrew	1/13	0.04			

Remarks

In KNP, moister conditions result in the dominance of red-backed voles, while in BNP and JNP deer mice predominate (Holroyd and Van Tighem 1983). Red-backed voles and deer mice were captured at a rate of 13.4 and 0.8/100 trap nights, respectively, in lodgepole pine forest (C6, C38, C39), 11.2 and 2.5 in Douglas fir forest (C1), 7.5 and 1.3 in spruce-poplar-lodgepole pine forest (C44), and 12.0 and 1.1 in Engelmann spruce-subalpine fir (C14) and western red cedar-Engelmann spruce-subalpine fir (C42) forests.

Vegetation Type correlates

Douglas fir/hairy wild rye (C1)
lodgepole pine/buffaloberry/showy aster (C6)
lodgepole pine/buffaloberry/pine grass (C38)
lodgepole pine/buffaloberry/bunchberry (C39)
lodgepole pine/buffaloberry/twinflower (C19)
lodgepole pine/buffaloberry/grouseberry (C18)
lodgepole pine/dwarf bilberry (C9)
Engelmann spruce-subalpine fir/false azalea (C14)
western red cedar/oval leaf blueberry (C42)
spruce-aspen-lodgepole pine-(paper birch)/buffaloberry/pine grass (C44)

SMALL MAMMAL ASSOCIATION 3

Moist spruce-subalpine fir forest

SMA 3 occurs in mesic to subhygric closed and open forests in the Montane and Subalpine Ecoregions. Soils are well to imperfectly drained, derived mainly from till or colluvium. Vegetation types include closed and open forests of white spruce (*Picea glauca*), Engelmann spruce (*Picea engelmannii*) and western larch (*Larix occidentalis*) with feathermoss (*Pleurozium schreberi* and *Hylocomium splendens*) dominated ground cover.

Definitive Species	freq.	dens.		freq.	dens.
red-backed vole	13/13	13.9			

Additional Species

deer mouse	3/13	0.2	masked shrew	2/13	0.2
dusky shrew	2/13	0.2	long-tailed vole	2/13	0.2
yellow-pine chipmunk	1/13	0.1	heather vole	1/13	0.06
northern bog lemming	1/13	0.04			

Remarks

Here, as in SMA III of BNP and JNP (Holroyd and Van Tighem 1983), red-backed voles are numerically dominant and deer mice are relatively rare, while in SMA 2 deer mice are common, but at low densities. Red-backed voles were captured at a rate of 15.0/100 trap nights in white spruce, Douglas fir and western larch closed forests (C5, C37, C45), 14.4 in Engelmann spruce-subalpine fir closed and open forests, (C13, C30, C34, O10), and 9.0 in lodgepole pine forest (C20). In both SMA's 2 and 3 in KNP, red-backed voles occur at much greater relative densities than in equivalent associations in BNP and JNP.

Vegetation Type correlates

white spruce-Douglas fir/feathermoss (C5)
Engelmann spruce-subalpine fir/feathermoss (C13)
lodgepole pine/green alder/feathermoss (C10)
lodgepole pine/false azalea/grouseberry (C20)
lodgepole pine/feathermoss (C11)
Engelmann spruce-subalpine fir/grouseberry (C15)
Engelmann spruce-subalpine fir/Labrador tea/crowberry (C30) (Corns and Achuff 1982)
Engelmann spruce-subalpine fir/heather/feathermoss (C34)
white spruce/buffaloberry/feathermoss (C37)
white spruce-western larch-Douglas fir/bunchberry (C45)
Engelmann spruce-subalpine fir/heather (O10)
Engelmann spruce-subalpine fir/rock willow/bracted lousewort (O14)
Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21)
Engelmann spruce-subalpine fir/green alder (C25)

SMALL MAMMAL ASSOCIATION 4

Montane and Lower Subalpine wet shrub/sedge meadow

SMA 4 occurs most commonly in the Montane and Lower Subalpine but ranges from the Montane to the Alpine in hygric to subhygric open forests, shrub and herb meadows, and fens. Soils are generally imperfectly or poorly drained and on morainal and fluvial material.

Definitive Species	**freq.**	**dens.**		**freq.**	**dens.**
meadow vole	7/7	2.2	red-backed vole	4/7	1.3
Additional Species					
masked shrew	2/7	0.2	northern bog lemming	1/7	0.1
yellow-pine chipmunk	2/7	0.4	deer mouse	1/7	0.1
dusky shrew	1/7	0.1			

Remarks

SMA 4 is numerically dominated by meadow voles. Red-backed voles can be dominant in wet open forests (O11). The capture rate of meadow voles was 2.7/100 trap nights in shrubby meadows (S1), 1.5 in herb meadows (H8), 2.5 in sedge meadows (H11), and 1.5 in wet spruce open forest (O11).

Vegetation Type correlates

dwarf birch-shrubby cinquefoil-willow/brown moss (S1)

yellow dryad-willow herb (H8)
water sedge-beaked sedge (H11)
spruce/Labrador tea/brown moss (O11)
willow/cinquefoil (S8)

SMALL MAMMAL ASSOCIATION 5

Upper Subalpine shrub/heath meadow

SMA 5 occurs on only three mesic to hygric Upper Subalpine and Alpine v.t.s in BNP and JNP (Holroyd and Van Tighem 1983). Two of the three v.t.s occur on similar morainal or colluvial landforms in KNP: subalpine larch-subalpine fir/heather (O13) and heather-everlasting (L5). A total of 600 trap nights in these two v.t.s yielded no small mammals. Sign of heather vole activity was common, therefore it is probable that SMA 5 does exist in KNP.

Definitive Species	**freq.**	**dens.**		**freq.**	**dens.**
heather vole					

Additional Species

long-tailed vole
red-backed vole
western jumping mouse
masked shrew
least chipmunk
northern bog lemming
deer mouse
dusky shrew

SMALL MAMMAL ASSOCIATION 6

Upper Subalpine spruce-subalpine fir open forest

SMA 6, although similar in species composition to SMA VI of BNP and JNP (Holroyd and Van Tighem 1983), was found on only one Upper Subalpine mesic to subhygric open forest type.

Definitive Species	**freq.**	**dens.**		**freq.**	**dens.**
red-backed vole	2/2	7.1	heather vole	1/2	1.3

Additional Species		
least chipmunk	1/2	0.2

Remarks

SMA 6 occurs in subalpine larch-subalpine fir/grouseberry-everlasting (C23) and Engelmann spruce-subalpine fir/heather (O10) in BNP and JNP, but only in Engelmann spruce-subalpine fir/valerian-fleabane (O9) in KNP (200 trap nights). Red-backed voles and heather voles were captured at a rate of 13.0 and 2.5/100 trap nights, respectively in O9. Red-backed voles were captured at a rate of 1.3/100 trap nights in C23, while no heather voles were captured in 200 trap nights.

SMALL MAMMAL ASSOCIATION 8

Avalanche shrub and meadow

SMA 8 occurs from the Montane to the Upper Subalpine on mesic to subhygric snow avalanche chutes on predominantly colluvial materials. Vegetation includes a variety of avalanche shrub and meadow v.t.s.

Definitive Species	freq.	dens.		freq.	dens.
long-tailed vole	3/3	3.2	western jumping mouse	3/3	1.4
meadow vole	2/3	1.3			

Additional Species

heather vole	1/3	0.5	masked shrew	2/3	0.4
yellow-pine chipmunk	1/3	0.2	dusky shrew	1/3	0.7

Remarks

Snow avalanche shrub and herb communities are common on colluvial slopes in the Lower Subalpine and Upper Subalpine of KNP. SMA 8 is not well defined because of low sample sizes, however it is likely that long-tailed voles and western jumping mice are definitive species, at least in herb meadow avalanche communities (H5) and some willow-dwarf birch communities (S4). Capture rates for long-tailed voles and western jumping mice were 3.3 and 2.3/100 trap nights, respectively in hairy wild rye-wild strawberry-fireweed (H5) avalanche communities and 3.0 and 0.5, respectively in willow-dwarf birch/fleabane (S4). It is probable that deer mice and red-backed voles are also definitive species in other shrub dominated avalanche communities. (*i.e.* S2, S13)

Vegetation Type correlates

subalpine fir-willow (S2)
green alder/fern (S13)
hairy wild rye-wild strawberry-fireweed (H5)
fleabane-valerian (H16)
fireweed-meadow rue (H22)

SMALL MAMMAL ASSOCIATION 9

Regenerating lodgepole pine shrub

SMA 9 occurs only in the Vermilion Pass burn area on mesic, well drained morainal and colluvial landforms with regenerating lodgepole pine (*Pinus contorta*) forests containing rhododendron (*Rhododendron albiflorum*), false azalea (*Menziesia glabella*), twinflower (*Linnaea borealis*), fireweed (*Epilobium angustifolium*), grouseberry (*Vaccinium scoparium*) and grasses (*Calamagrostis* spp. and *Elymus innovatus*).

Definitive Species	freq.	dens.		freq.	dens.
deer mouse	2/2	1.8	red-backed vole	1/2	0.8
Additional Species					
meadow vole	1/2	0.3	least chipmunk	1/2	0.3
heather vole	1/2	0.3	yellow-pine chipmunk	1/2	0.3
western jumping mouse	nd	nd			

Remarks

SMA 9 is similar to SMA's 1 and 2, but has much lower relative densities of major species plus a sufficiently different assemblage of species to warrant a separate association. A similar species assemblage was reported from earlier studies in the burn (Shank 1971, Reid 1972, Fitzmartyn 1973, Guy 1975, Harris 1976). Deer mice were numerically dominant during these early years, but red-backed voles increased steadily from 1971 to 1975 (Harris 1976). No doubt as succession procedes to closed lodgepole pine and spruce-fir forest, red-backed voles will become dominant. Harris (1976) also reports that western jumping mice were prevalent in the burn. None was captured during the present inventory, however trapping was conducted in October after western jumping mice have begun hibernation.

BREEDING BIRD COMMUNITIES

In KNP, Breeding Bird Communities (BBC's) were defined on the basis of data collected on 605 circular bird census plots. These assemblages are synthetic concepts; they are not meant to reflect ecological relationships among species but are purely descriptive. They integrate a great deal of bird information into the ELC, particularly in the map legend. BBC's are also described in BNP and JNP (Holroyd and Van Tighem 1983) and in MRNP and GNP (Van Tighem and Gyug [1984]). Similar BBC's in KNP are included in those already defined for BNP and JNP, and MRNP and GNP. All BBC's are numbered consecutively to form one system common to all the mountain parks.

Several vegetation types (v.t.s) may occur within one Ecosite. Thus, the v.t. is the basic unit in identifying BBC's. It is assumed that each BBC will occur in the v.t. in which it was found, wherever that v.t. occurs. Ecosites not sampled by circular bird census plots are assumed to support species that occur elsewhere in the v.t.s that characterize that Ecosite.

By the methods described above, density indices (DI's) were calculated for each species on each of the v.t.s sampled. These DI's generally fall between 0.01 and 10.00 and represent the density of a species relative to its density in other v.t.s and relative to the densities of other species.

BBC's were derived by comparing the species present, and their DI's, among each of the various v.t.s. In order to increase the significance of presence/absence, all non-zero DI values were increased by 10 and the values were then clustered by BMPD (Hartigan 1983) to find which v.t.s were most similar with regard to bird species present and the relative densities at which they occur.

BBC's were not identified solely on the basis of the cluster analysis, since the analysis treats all species equally. Widespread species like American Robin and Golden-crowned Kinglet are of less value in defining BBC's than are American Redstart and Water Pipit with more specialized habitat needs. When BBC's had been defined, the DI of each species was averaged for all the v.t.s where the BBC occurs and the averages totalled to produce a DI for that BBC. By this means, the relative density of birds in one BBC could be compared to another.

BBC's are described by a number, a name for the characteristic habitat, followed by a description of the habitat. Next is a list of species with their DI's in that BBC. Since circular bird census plots were used in KNP rather than line transects as in BNP and JNP, DI's are not comparable to those in Holroyd and Van Tighem (1983). ***Dominant species*** have DI's >0.1 That is, they are the most frequent or prevailing species. ***Definitive species*** are dominant species which best define the BBC; they are confined to that BBC, occur in it at much higher densities than elsewhere or occur in combination with other definitive species with which they do not occur elsewhere. A species may be definitive of more than one BBC. ***Additional species*** are all other species that were recorded in that habitat with DI's lower than 0.1.

The ***Remarks*** section describes the areal extent of the BBC and variability in composition, particularly as it relates to habitat variability. Last is a list of ***Vegetation Types*** in which the BBC occurs. These v.t.s are described in Chapter III. BBC's for each Ecosite are presented in the wildlife map legend (Map Supplement) and the Ecosite accounts in Chapter V.

BREEDING BIRD COMMUNITY 1

Poplar forest

BBC 1 occurs in the Montane and Lower Subalpine Ecoregions, mostly in the Kootenay Valley. Slopes are gentle to moderate and moist on morainal and fluvial landforms. Stands of trembling aspen (***Populus tremuloides***) and balsam poplar (***Populus balsamifera***) occur, usually mixed with conifers including lodgepole pine (***Pinus contorta***), white spruce (***Picea glauca***) and Douglas fir(***Pseudotsuga menziesii***). Buffaloberry (***Shepherdia canadensis***), wild rose (***Rosa acicularis***) and juniper (***Juniperus communis***) dominate a species-rich shrub layer. The herb cover is mostly pine grass (***Calamagrostis rubescens***) and hairy wild rye (***Elymus innovatus***).

Dominant Species

Yellow-rumped Warbler	.602	Golden-crowned Kinglet	.342
American Robin	.299	Dark-eyed Junco	.266
Black-capped Chickadee	.260		

Definitive Species

Yellow-rumped Warbler	.602	Golden-crowned Kinglet	.342
American Robin	.299	Dark-eyed Junco	.266
Black-capped Chickadee	.260	Townsend's Warbler	.239
Hammond's Flycatcher	.228	Swainson's Thrush	.204
Chipping Sparrow	.177	Hairy Woodpecker	.124
Brown-headed Cowbird	.059	Orange-crowned Warbler	.050
Warbling Vireo	.047	Ruby-crowned Kinglet	.043
Northern Flicker	.027	Yellow-bellied Sapsucker	.019
Wilson's Warbler	.016	Solitary Vireo	.011

Additional Species

Red Crossbill	.175	Gray Jay	.125
Rufous Hummingbird	.163	Pine Siskin	.127
Winter Wren	.060	Mountain Chickadee	.053
Boreal Chickadee	.039	Townsend's Solitaire	.034
Varied Thrush	.024	Spruce Grouse	.022
Common Raven	.020	Olive-sided Flycatcher	.018
Evening Grosbeak	.013	Common Yellowthroat	.012
Western Tanager	.012	Red-breasted Nuthatch	.011
Three-toed Woodpecker	.009	Pine Grosbeak	.009

Steller's Jay	.006	Pileated Woodpecker	.005
Purple Finch	.004	Lincoln's Sparrow	.003

Remarks

The overall density in BBC 1 is medium (4.0). Yellow-bellied Sapsucker, Hairy Woodpecker and Hammond's Flycatcher reach their highest densities here. Downy Woodpecker is restricted to this BBC.

Vegetation Type correlates

aspen/hairy wild rye-peavine (C16)
lodgepole pine/buffaloberry/pine grass (C38)
spruce-aspen-lodgepole pine-(paper birch)/buffaloberry/pine grass (C44)

BREEDING BIRD COMMUNITY 2

Stunted aspen

BBC 2 is limited to a few areas such as Mount Wardle on dry southwest facing avalanche slopes at 1200 to 1400 m. The tree canopy ranges from closed to open and consists of stunted aspen (*Populus tremuloides*), with some paper birch (*Betula papyrifera*), maple (*Acer glabrum*) and green alder (*Alnus crispa*). The shrub layer is well developed and contains aspen (*Populus tremuloides*), buffaloberry (*Shepherdia canadensis*), and saskatoon (*Amelanchier alnifolia*).

Dominant Species

Yellow-rumped Warbler	.160	Warbling Vireo	.100
Chipping Sparrow	.085	Townsend's Solitaire	.080

Definitive Species

Warbling Vireo	.100	Townsend's Solitaire	.080
MacGillivray's Warbler	.073	Dusky Flycatcher	.060
Orange-crowned Warbler	.060		

Additional Species

Pine Siskin	.404	American Robin	.020
Hammond's Flycatcher	.020	Hermit Thrush	.020

Remarks

Densities are low for most species, and the average DI is lowest of all the BBC's (0.7) in KNP. Blue Grouse and Purple Finch also occur here.

Vegetation Type correlates

aspen-dwarf birch/bearberry (S16)
aspen/hairy wild rye-showy aster (C22)

BREEDING BIRD COMMUNITY 3

Douglas fir forest

BBC 3 occurs in open and closed Douglas fir (***Pseudotsuga menziesii***) forest in the Montane and Lower Subalpine between 1050 and 1700 m. Open forest with grassland occurs only in the southwest corner of KNP at Stoddart Creek in the O24, O5, H6 and H19 v.t.s. Stands of aspen (***Populus tremuloides***) may occur within C1 forest, and contain warblers and vireos normally absent from coniferous woods.

Dominant Species

Chipping Sparrow	.889	Yellow-rumped Warbler	.530
Dark-eyed Junco	.357	Golden-crowned Kinglet	.330
American Robin	.236	Mountain Chickadee	.226

Definitive Species

Chipping Sparrow	.889	Yellow-rumped Warbler	.530
Dark-eyed Junco	.357	Golden-crowned Kinglet	.330
American Robin	.236	Mountain Chickadee	.226
Western Tanager	.160	Solitary Vireo	.170
Warbling Vireo	.098	Dusky Flycatcher	.081
Red-breasted Nuthatch	.077	Vesper Sparrow	.073
Cassin's Finch	.051	Blue Grouse	.033
Cedar Waxwing	.027	American Crow	.008

Additional Species

Black-capped Chickadee	.163	Pine Siskin	.160
Orange-crowned Warbler	.098	Hairy Woodpecker	.083
Hammond's Flycatcher	.073	Spruce Grouse	.060
Townsend's Warbler	.055	Ruffed Grouse	.050
Wilson's Warbler	.044	Gray Jay	.043
Swainson's Thrush	.039	Common Raven	.033
Ruby-crowned Kinglet	.024	MacGillivray's Warbler	.020
Rock Wren	.018	Western Wood Pewee	.015
Red Crossbill	.014	Winter Wren	.010
Brown-headed Cowbird	.010	Evening Grosbeak	.010
Pileated Woodpecker	.005		

Remarks

BBC 3 has the second highest average DI (4.9) of all BBC's in KNP. Other species occurring in v.t.s where BBC 3 occurs include Common Nighthawk, Black-billed Magpie, White-breasted Nuthatch, Barred Owl, Northern Pygmy-Owl and Great Horned Owl. Two species found nesting here but not recorded on circular bird census plots are American Kestrel and Cooper's Hawk. Cooper's Hawk, American Kestrel, and Common Nighthawk are on the Blue List (Tate and Tate 1982).

Vegetation Type correlates

Douglas fir/hairy wild rye (C1)
Douglas fir/juniper/bearberry (O5)
Douglas fir-ponderosa pine/wheatgrass (O24)

BREEDING BIRD COMMUNITY 5

Spruce-pine closed forest

BBC 5 occurs in Montane and Lower Subalpine forest from 1400 to 1970 m. The canopy is composed of lodgepole pine (*Pinus contorta*), spruce (*Picea* spp.) or Douglas fir (*Pseudotsuga menziesii*), but in limited areas such as Vérendrye Creek western red cedar (*Thuja plicata*) may occur with Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*). The shrub layer is well developed and contains false azalea (*Menziesia glabella*), rhododendron (*Rhododendron albiflorum*), tall bilberry (*Vaccinium membranaceum*) and Labrador tea (*Ledum groenlandicum*).

Dominant Species

Golden-crowned Kinglet	.563	Townsend's Warbler	.447
Yellow-rumped Warbler	.347	Pine Siskin	.225

Definitive Species

Golden-crowned Kinglet	.563	Townsend's Warbler	.447
Winter Wren	.153	Boreal Chickadee	.141
Swainson's Thrush	.113	Varied Thrush	.109
Brown Creeper	.072	Steller's Jay	.005

Additional Species

American Robin	.088	Dark-eyed Junco	.085
Black-capped Chickadee	.073	Wilson's Warbler	.069
Chipping Sparrow	.058	Pine Grosbeak	.054
Hammond's Flycatcher	.050	Mountain Chickadee	.047
Evening Grosbeak	.038	Gray Jay	.029
Red-breasted Nuthatch	.021	Ruby-crowned Kinglet	.018
Western Tanager	.018	Three-toed Woodpecker	.015
Red Crossbill	.014	Common Raven	.012
Olive-sided Flycatcher	.012	Hermit Thrush	.004
Tennessee Warbler	.004	Northern Pygmy-Owl	

Remarks

The overall DI is medium (2.9), with Steller's Jay and Winter Wren reaching their highest densities in this BBC.

Vegetation Type correlates

white spruce-Douglas fir/feathermoss (C5)
lodgepole pine/feathermoss (C11)
lodgepole pine/false azalea/grouseberry (C20)
white spruce-subalpine fir/bunchberry-horsetail (C41)
western red cedar/oval leaf blueberry (C42)

BREEDING BIRD COMMUNITY 6

Spruce fen

BBC 6 is similar to BBC 9, and often the two are adjacent. It occurs in the Montane and Lower Subalpine where white spruce (*Picea glauca*) or lodgepole pine (*Pinus contorta*) forests border wet shrublands of Labrador tea (*Ledum groenlandicum*), dwarf birch (*Betula glandulosa*), and willows (*Salix* spp.), with sedges (*Carex* spp.), and brown moss (*Tomenthypnum nitens*).

Dominant Species

Common Yellowthroat	1.91	Yellow-rumped Warbler	.85
Chipping Sparrow	.84	Golden-crowned Kinglet	.53
Hammond's Flycatcher	.53	Townsend's Warbler	.46

Definitive Species

Common Yellowthroat	1.91	Yellow-rumped Warbler	.85
Chipping Sparrow	.84	Golden-crowned Kinglet	.53
Hammond's Flycatcher	.53	Townsend's Warbler	.56
Common Snipe	.42	Lincoln's Sparrow	.42
Boreal Chickadee	.35	Wilson's Warbler	.23
Varied Thrush	.11	Tennessee Warbler	.07

Additional Species

Dark-eyed Junco	.39	American Robin	.36
Rufous Hummingbird	.29	Mountain Chickadee	.25
Olive-sided Flycatcher	.21	Brown-headed Cowbird	.15
Warbling Vireo	.14	Belted Kingfisher	.11
Solitary Vireo	.11	Ruby-crowned Kinglet	.11
Yellow-bellied Sapsucker	.11	Gray Jay	.09
Barn Swallow	.09	Northern Flicker	.07
Canada Goose	.04	Swainson's Thrush	.04
Orange-crowned Warbler	.04	Western Wood Pewee	.04
Pine Siskin	.04	Tree Swallow	.04

Remarks

The DI for this community is very high (9.4), and species diversity is high as well. Blackpoll Warbler and Northern Waterthrush are normally present in these habitats, but were not detected on circular bird census plots.

Vegetation Type correlates

spruce/Labrador tea/brown moss (O11)

BREEDING BIRD COMMUNITY 7

Upper Subalpine Coniferous Open Forest

BBC 7 is confined to the Upper Subalpine Ecoregion. Open coniferous forests with heath or herb meadows characterize the habitats frequented by this BBC. At highest elevations, coniferous cover is limited to krummholz of subalpine fir (*Abies lasiocarpa*), while at lower elevations, forest cover is heavier, with only scattered openings.

Dominant Species

White-winged Crossbill	.819	Chipping Sparrow	.407
Yellow-rumped Warbler	.341	Rosy Finch	.274

Definitive Species

White-winged Crossbill	.819	Chipping Sparrow	.407
Yellow-rumped Warbler	.341	Mountain Chickadee	.233
Fox Sparrow	.194	Varied Thrush	.193
Dark-eyed Junco	.189	Winter Wren	.144
Hermit Thrush	.124	Pine Grosbeak	.070
Ruby-crowned Kinglet	.059	White-crowned Sparrow	.015

Additional Species

Rosy Finch	.274	Water Pipit	.226
Pine Siskin	.223	Golden-crowned Kinglet	.147
Clark's Nutcracker	.062	American Robin	.054
Rufous Hummingbird	.049	Gray Jay	.047
Townsend's Solitaire	.043	Golden Eagle	.020
White-tailed Ptarmigan	.018	Red Crossbill	.016
Dusky Flycatcher	.010	Wilson's Warbler	.008
Boreal Chickadee	.008	Black-capped Chickadee	.008
Red-breasted Nuthatch	.007	Northern Flicker	.006
Warbling Vireo	.004	Evening Grosbeak	.003
Townsend's Warbler	.003	Olive-sided Flycatcher	.003
Purple Finch	.003		

Remarks

The average DI of this BBC is medium (4.0), but high densities of Mountain Chickadee, Ruby-crowned Kinglet, Varied Thrush and Yellow-rumped Warbler occur here. Brewer's Sparrow also occurs locally in BBC 7 but was not recorded on circular bird census plots. BBC 9 contains birds characteristic of both closed Subalpine forest and of Alpine meadow.

Vegetation Type correlates

Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4)
Engelmann spruce-subalpine fir/valerian-fleabane (O9)
Engelmann spruce-subalpine fir/heather (O10)
subalpine larch-subalpine fir/heather (O13)

BREEDING BIRD COMMUNITY 8

Subalpine Coniferous Closed Forest

BBC 8 is widespread and common in the coniferous forests of the Lower and Upper Subalpine Ecoregions. It is most typical of closed-canopy forests of subalpine fir (*Abies lasiocarpa*) and Engelmann spruce (*Picea engelmannii*) but also occurs in some open forests. It is widespread in the Vermilion watershed.

Dominant Species

Golden-crowned Kinglet	.643	Townsend's Warbler	.320
Pine Siskin	.276	Yellow-rumped Warbler	.268
Winter Wren	.215	Wilson's Warbler	.208

Definitive Species

Golden-crowned Kinglet	.643	Townsend's Warbler	.320
Winter Wren	.215	Boreal Chickadee	.163
Gray Jay	.145	Hermit Thrush	.131
Varied Thrush	.109	Pine Grosbeak	.104
Brown Creeper	.078	Fox Sparrow	.073
Spruce Grouse	.043	Three-toed Woodpecker	.026

Additional Species

Wilson's Warbler	.208	Chipping Sparrow	.140
Mountain Chickadee	.129	Swainson's Thrush	.127
American Robin	.058	Ruby-crowned Kinglet	.048
Black-capped Chickadee	.026	White-winged Crossbill	.025
Hairy Woodpecker	.026	Warbling Vireo	.024
Brown-headed Cowbird	.018	MacGillivray's Warbler	.016
Rufous Hummingbird	.016	Hammond's Flycatcher	.015
Yellow-bellied Sapsucker	.013	Red-breasted Nuthatch	.015
Orange-crowned Warbler	.009	Common Raven	.009
Evening Grosbeak	.006	Tennessee Warbler	.008
Clark's Nutcracker	.005	Olive-sided Flycatcher	.006
Solitary Vireo	.004	Red Crossbill	.005
White-crowned Sparrow	.002	Western Tanager	.003
Northern Flicker	.002	Townsend's Solitaire	.002
Pine Siskin	.276		

Remarks

The DI is high (4.3). Boreal Chickadee, Hermit Thrush and Brown Creeper reach their highest densities here. Boreal Owls occur in these habitats but were not recorded on circular bird census plots.

Vegetation Type correlates

Engelmann spruce-subalpine fir/false azalea (C14)
Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21)
Engelmann spruce-subalpine fir/green alder (C25)
Engelmann spruce-subalpine fir/rock willow/bracted lousewort (O14)

BREEDING BIRD COMMUNITY 9

Shrub wetland

BBC 9 occurs only in the Montane Ecoregion, on wetland vegetation mosaics of wet sedge (*Carex* spp.) meadows, willow (*Salix* spp.) stands, and clumps of spruce (*Picea glauca*) forest. It is most common along the bottom of the Kootenay River valley, adjacent to small ponds and along small streams, particularly Dolly Varden Creek.

Dominant Species

Chipping Sparrow	.59	Yellow-rumped Warbler	.54
Pine Siskin	.50	American Robin	.47
Common Yellowthroat	.41	Townsend's Warbler	.32

Definitive Species

Common Yellowthroat	.41	Lincoln's Sparrow	.23
Wilson's Warbler	.20	Savannah Sparrow	.18
Spotted Sandpiper	.15	Brown-headed Cowbird	.10
Tennessee Warbler	.09	Willow Flycatcher	.09

Additional Species

Golden-crowned Kinglet	.14	Fox Sparrow	.14
Hammond's Flycatcher	.09	Swainson's Thrush	.09
Varied Thrush	.09	Western Wood Pewee	.09
Ruby-crowned Kinglet	.09	Evening Grosbeak	.09
Warbling Vireo	.05	Orange-crowned Warbler	.05

Remarks

In KNP, BBC 9 has a high DI (4.8) and high species diversity. Pond surveys conducted during the breeding season revealed species that were typical of this BBC but because of low densities were not detected on circular bird census plots. These include Blackpoll Warbler, American Redstart, Sora Rail, Common Snipe, Red-winged Blackbird, Least Flycatcher, Yellow Warbler, Lesser Yellowlegs and Solitary Sandpiper. Water bodies associated with these areas may contain Blue-winged Teal, Ring-necked Duck, Mallard, American Coot and Pied-billed Grebe.

This BBC includes a number of species that are rare or local in KNP, and it is of limited distribution due to the scarcity of appropriate habitat.

Vegetation Type correlates

dwarf birch-shrubby cinquefoil-willow/brown moss (S1)
water sedge-beaked sedge (H11)

BREEDING BIRD COMMUNITY 12

Avalanche slope

BBC 12 is confined to the Lower and Upper Subalpine Ecoregions, occurring where regular avalanching maintains mosaics of shrubs, lush herb meadows and exposed rock. On dry slopes where aspen (*Populus tremuloides*), saskatoon (*Amelanchier alnifolia*) and buffaloberry (*Shepherdia canadensis*) are dominant, this BBC is replaced by BBC 2.

Dominant Species

Rufous Hummingbird	.900	Wilson's Warbler	.633
Chipping Sparrow	.447	Golden-crowned Kinglet	.384

Definitive Species

Rufous Hummingbird	.900	Wilson's Warbler	.633

Chipping Sparrow	.447	Fox Sparrow	.320
Dark-eyed Junco	.175	MacGillivray's Warbler	.118
White-crowned Sparrow	.081	Orange-crowned Warbler	.050
Warbling Vireo	.048	Olive-sided Flycatcher	.016

Additional Species

Yellow-rumped Warbler	.257	Pine Siskin	.192
Townsend's Warbler	.160	Spotted Sandpiper	.152
American Robin	.100	Evening Grosbeak	.064
Winter Wren	.064	Hammond's Flycatcher	.048
Rosy Finch	.043	Gray Jay	.040
Brown-headed Cowbird	.036	Hermit Thrush	.031
Ruby-crowned Kinglet	.016	Red-breasted Nuthatch	.016
Clark's Nutcracker	.016		

Remarks

Average DI for all species is high (4.5), although it is below BBC's 3 and 9. Species which reach their highest densities here are: Rufous Hummingbird, MacGillivray's Warbler and Wilson's Warbler.

Vegetation Type correlates

subalpine fir-willow (S2)
green alder/fern (S13)

BREEDING BIRD COMMUNITY 15

Dryad mat

BBC 15 is common in the Vermilion and Kootenay valleys, occurring in the Montane and Lower Subalpine on gravelly river floodplains. Mats of yellow dryad (*Dryas drummondii*) with scattered small spruce (*Picea* spp.) and clumps of willow (*Salix* spp.) and shrubby cinquefoil (*Potentilla fruticosa*) are characteristic of the habitat, with much exposed gravel and silt.

Dominant Species

Spotted Sandpiper	1.02	Chipping Sparrow	.23

Definitive Species

Spotted Sandpiper	1.02	Chipping Sparrow	.23

Additional Species

Dark-eyed Junco	.21	Hammond's Flycatcher	.21
Olive-sided Flycatcher	.21	Vesper Sparrow	.21
White-crowned Sparrow	.11	Townsend's Warbler	.11

Remarks

BBC 15 has a low average DI (2.3) and low species diversity. Only Spotted Sandpiper reaches its highest densities here.

Vegetation Type correlates

yellow dryad-willow herb (H8)

BREEDING BIRD COMMUNITY 17

Moist Upper Subalpine and Alpine meadows

BBC 17 occurs at or above timberline on slopes and meadows where snow remains until late in the season. Heather (*Phyllodoce* spp.) and forbs dominate the vegetation. Engelmann spruce (*Picea engelmannii*), subalpine larch (*Larix lyallii*), or subalpine fir (*Abies lasiocarpa*) provide small islands of cover.

Dominant Species

Water Pipit	2.124	Rosy Finch	1.152

Definitive Species

Water Pipit	2.124	Rosy Finch	1.152
Clark's Nutcracker	.019	White-crowned Sparrow	.029

Additional Species

Chipping Sparrow	.229	American Robin	.219
Killdeer	.095	White-winged Crossbill	.086
Yellow-rumped Warbler	.057	Spotted Sandpiper	.048
Pine Siskin	.047	Mountain Chickadee	.038
Fox Sparrow	.032	Dark-eyed Junco	.031
Varied Thrush	.019	Townsend's Solitaire	.019

Remarks

Average DI is medium (4.2). Rosy Finch and Water Pipit attain their highest DI's here. White-tailed Ptarmigan was not recorded on circular bird census plotss but should also be considered a component of BBC 17.

Vegetation Type correlates

heather-everlasting (L5)
fleabane-valerian (H16)

BREEDING BIRD COMMUNITY 18

Dry Alpine tundra

BBC 18 occurs on well-drained Alpine meadows dominated by low, mat-forming vegetation. Since its habitat is limited in extent, BBC 18 is uncommon in KNP.

Dominant Species

Rosy Finch	.775	Water Pipit	.515

Definitive Species

Rosy Finch	.775	Water Pipit	.515
Townsend's Solitaire	.094		

Additional Species

Pine Siskin	.065	Clark's Nutcracker	.065
White-tailed Ptarmigan			

Remarks

Both the average DI (1.5) and species diversity are low. All species that occur here occur elsewhere at higher densities. White-tailed Ptarmigan was not recorded on circular bird census plots.

Vegetation Type correlates

mountain avens-snow willow-moss campion (H1)
saxicolous lichen (H12)
everlasting-grouseberry (H17)

BREEDING BIRD COMMUNITY 19

Mixed forest

BBC 19 is confined to the Montane Ecoregion in the Kootenay Valley, where fires and insect infestations have produced a complex forest mosaic. Clumps of white spruce (*Picea glauca*), aspen (*Populus tremuloides*) and lodgepole pine (*Pinus contorta*) are interspersed with small grassy clearings and stands of green alder (*Alnus crispa*) and willow (*Salix* spp.). Due to the complexity of vegetation, BBC 19 is comprised of species typical of several other BBC's.

Dominant Species

Golden-crowned Kinglet	.265	Black-capped Chickadee	.260
American Robin	.259	Yellow-rumped Warbler	.245
Townsend's Warbler	.200		

Definitive Species

Golden-crowned Kinglet	.265	Black-capped Chickadee	.260
American Robin	.259	Yellow-rumped Warbler	.245
Townsend's Warbler	.200	Chipping Sparrow	.177
Dark-eyed Junco	.125	Swainson's Thrush	.119
Pine Siskin	.088	Solitary Vireo	.062
Wilson's Warbler	.061	Brown-headed Cowbird	.055
Orange-crowned Warbler	.052	Hammond's Flycatcher	.046
Red-breasted Nuthatch	.026		

Additional Species

Three-toed Woodpecker	.021	Evening Grosbeak	.043
Olive-sided Flycatcher	.016	Pine Grosbeak	.025
Red Crossbill	.013	Gray Jay	.018
Winter Wren	.010	Western Wood Pewee	.016

Ruby-crowned Kinglet	.006	Pileated Woodpecker	.012
Western Tanager	.006	Ruby-crowned Kinglet	.006
Varied Thrush	.005	Warbling Vireo	.005
Yellow Warbler		Red-eyed Vireo	
Cedar Waxwing			

Remarks

BBC 19 has a low average DI (2.2) and a high species diversity. It contains species typical of both deciduous and coniferous habitats as well as forest edge species. Species not recorded on circular bird census plotss which are nonetheless members of this BBC include Red-tailed Hawk, American Kestrel and Northern Pygmy-Owl.

Vegetation Type correlates

lodgepole pine/buffaloberry/showy aster (C6)
lodgepole pine/green alder/feathermoss (C10)
lodgepole pine/Labrador tea (C29)
lodgepole pine/buffaloberry/bunchberry (C39)
white spruce/buffaloberry/feathermoss (C37)
white spruce-western larch-Douglas fir/bunchberry (C45)

BREEDING BIRD COMMUNITY 21

Subalpine burn

BBC 21 occurs in the Subalpine where there is an open, low canopy of lodgepole pine (*Pinus contorta*) with a lush shrub understory and numerous standing spars and deadfall.

Dominant Species

Dark-eyed Junco	.49	Rufous Hummingbird	.32
Townsend's Solitaire	.16	American Robin	.14
Yellow-rumped Warbler	.13	Golden-crowned Kinglet	.12

Definitive Species

Rufous Hummingbird	.32	Wilson's Warbler	.09
Mountain Bluebird	.04	Olive-sided Flycatcher	.04
MacGillivray's Warbler	.02	Dusky Flycatcher	.01
Northern Hawk-Owl	.01	White-crowned Sparrow	.01
Chipping Sparrow	.06	Mountain Chickadee	.03
Northern Flicker	.03		

Additional Species

Pine Siskin	.07	Hermit Thrush	.07
Ruby-crowned Kinglet	.04	Swainson's Thrush	.03
Gray Jay	.03	Townsend's Warbler	.03
Fox Sparrow	.01	Clark's Nutcracker	.01

Remarks

BBC 21 has a medium average DI (2.3) and a low species diversity. All species occur elsewhere at higher densities. Species not recorded on circular bird census plotss but which characterize this community include Hairy Woodpecker and Three-toed Woodpecker.

Vegetation Type correlates

lodgepole pine/twinflower-fireweed (S5)

CHAPTER V - ECOLOGICAL INTEGRATION OF LANDFORMS, SOILS, VEGETATION AND WILDLIFE

ECOLOGICAL LAND CLASSIFICATION METHODOLOGY

B.D. Walker, W.S. Taylor and G.M. Coen

PHILOSOPHICAL PRINCIPLES

There have been various approaches to natural resource inventories in Canadian national parks. Experience has shown that, for ease of use, all resource sectors should be linked to one set of map polygons of appropriate scale (1:50,000 was chosen for KNP) and the legend should describe holistic, repeating, ecological map unit concepts. For the mountain national parks, this mapping approach was developed during the Lake Louise pilot study (Holland 1976, Walker *et al.* 1978) and further refined in the Banff-Jasper Ecological Land Classification (Coen *et al.* 1982, Walker *et al.* 1982b). The KNP Ecological Land Classification is based on design principles and concepts developed in the BNP and JNP project and uses many of the same Ecosection and Ecosite concepts.

Three guidelines were used to develop the mapping procedure for ecological land classification in the mountain national parks:

1. Map, legend, and report should be easily interpretable.
2. Map unit concepts should be repetitive and holistic.
3. Map information should be uniform in reliability and intensity.

These guidelines were met by using a controlled legend (Mapping Systems Working Group 1981) and simple map symbol that encompasses a holistic ecological concept comprising landform, soil, and vegetation. Only the slope and selected landscape modifying processes vary independently of the concept as applied to map polygons. This allows the development of an ecological map unit concept (Jurdant *et al.* 1975, Rowe 1979), limits the number of concepts, permits legend interpretation followed by mechanical labelling of repetitive map polygons, and encompasses many landscape features in an easily remembered symbol. It also allows transfer of experience from a familiar area to an unfamiliar but similarly labelled area, without reference to the many specific landscape components such as texture or calcareousness.

Map delineations were chosen to correspond with changes in landscape features, usually landform. Such changes usually can be correlated with soil and vegetation changes, which allows reliable extrapolation of Ecosite boundaries on aerial photographs. At a scale of 1:50,000, the smallest practical map polygon, about 0.5 to 1.0 cm^2, represents 10 to 25 ha. Thus, these were the smallest contrasting polygons delineated. Survey intensity corresponds to Level 3 of the Soil Mapping System for Canada (Mapping Systems Working Group 1981). The legend is organized hierarchically, *i.e.* the taxonomic units Ecoregion, Ecosection, and Ecosite are conceptually hierarchical. Attempts have been made elsewhere to map polygons named by hierarchical level and then to subdivide these large polygons, naming the smaller units by a lower category in the hierarchical taxonomy (Airphoto Analysis Associates 1975). This hierarchical or nested mapping method was not used in the BNP and JNP (Coen *et al.* 1982) or KNP inventories.

MAPPING METHODOLOGY

METHODOLOGY OF LEGEND DEVELOPMENT

No nationally acceptable taxonomic system for ecological land classification presently exists. There are guidelines (Lacate 1969, Jurdant *et al.* 1975, Wiken 1980) useful for developing ecological land classifications, but they are oriented more towards landscape mapping than to landscape taxonomy. They recommend utilizing, as building blocks, taxonomies developed for single components of the landscape, *e.g.* a soil classification. Ecological land classification in the mountain national parks, as initiated by the BNP and JNP inventory, uses a conceptual taxonomy based on other taxonomies. A vegetation ***community type*** taxonomy was developed (Achuff 1982, Corns and Achuff 1982) and an existing landform classification was slightly modified (C.S.S.C. 1978a, Walker *et al.* 1982a). These were combined with an existing soil taxonomy (C.S.S.C. 1978a) to form a legend that defined the map units (Ecosites). The vegetation and landform taxonomies were expanded for KNP to include features not previously encountered (see methodologies in preceding chapters). This allowed modification of the BNP and JNP legend to fit KNP. Thus, there is unity between the two legends and the landscapes of these three national parks are uniformly accommodated.

An iterative process, involving large amounts of data, was used to develop the component taxonomies and the ecological land classification legend. Pretyping of probable map unit boundaries was done on 1:63,360 scale, black and white aerial photographs. During the next phase, landform, soil, vegetation, and some wildlife data were collected simultaneously along common transects and at common observation sites in the field. Traverses were selected for optimal coverage of different landscapes, particularly over an altitudinal range. Observation sites were selected to represent the most common landform-soil-vegetation-wildlife condition within each map delineation. Occasionally, sites were chosen to examine some special but less common set of conditions. Site locations were noted on the 1:63,360 photos. The data were computer coded and analyzed to develop the component taxonomies and ecological land classification legend.

The pretyped map unit boundaries were corrected and refined as the field work progressed and the legend was refined. Also used were 1:25,000 scale, black and white, color and color IR photographs. Completed photo mapping was transferred to 1:50,000 base maps and then drafted and digitized by the Cartography Section, Land Resource Research Institute, Ottawa.

In keeping with the holistic approach of the inventory, wildlife data were used to develop Ecosite importance ratings for selected species (see methodologies in Chapter IV and Van Tighem and Gyug [1984]). In addition, wildlife data identified as critical by the wildlife team, influenced decisions about Ecosite separations and about assignment of vegetation types (v.t.s) to Ecosites. Thus, the Ecosite concepts are defined in terms of landform, soil, and vegetation components, some of which were chosen for their usefulness in identifying wildlife habitat.

DESIGN OF THE MAP LEGEND

The current ecological land classification guidelines (Wiken 1980) were the starting point for developing the map legend used for the BNP-JNP and KNP ecological inventories. To develop the taxonomy, class limits should have been defined for each of the hierarchical levels and subsequent taxa. This would have resulted in a matrix of ***pigeon holes*** into which the ecological universe could be partitioned. Since only a small portion of the ecological universe is present in KNP, it was possible to develop credible taxon limits for only portions of the taxonomy. Thus, a map legend was developed which separates map concepts coincident with probable taxon limits wherever possible. Extending the ecological inventory from BNP and JNP to KNP resulted in expansion of knowledge about that contiguous part of the ecological universe. Consequently, there is extensive use in KNP of BNP and JNP Ecosections, although new Ecosite concepts were developed. Expanded knowledge sometimes led to a refinement of an existing map concept but for which a name change was not necessary.

The following discussion of Ecoregions, Ecosections, and Ecosites show how the hierarchical taxonomic levels influenced the map legend. Ecodistrict separations (Wiken 1980) were not made.

Ecoregions

Three Ecoregions (ecological zones) occur in KNP: Montane, Subalpine, and Alpine (Fig. 10). The Subalpine Ecoregion was further divided into Lower Subalpine and Upper Subalpine portions. The Ecoregion is the broadest level of ecosystem classification used in this study and is based primarily upon differences in vegetation physiognomy and species composition which reflect differences in macroclimate. An Ecoregion, as used here, is conceptually similar to the zone of Daubenmire (1968), La Roi (1975), and Lea (1980, 1983), the biogeoclimatic zone of Krajina (1965) and Utzig *et al.* (1983), the biophysical region of Lacate (1969), and the Forest Section of Rowe (1972). Climatic, soil, and vegetational characteristics of each Ecoregion are described in Chapters I to III of this report.

Ecosections

Ecoregions are conceptually divided into 31 Ecosections based on broad genetic material and drainage class differences. Ecosections are named after geographic features and assigned a two letter connotative symbol. Many Ecosections established for the BNP and JNP inventory (Walker *et al.* 1982d) are used in KNP.

Six genetic material classes resulted in the establishment of Ecosections (Table 74). These are: glacial (including morainal and ice contact stratified drift), glaciofluvial, fluvial (including fluviolacustrine), colluvial, landslide, and residual (including regolith). These six groups were divided into two moisture regimes: wet terrain with poorly and very poorly drained soils (C.S.S.C. 1978b) and non-wet terrain with moderately well drained and drier soils. Imperfectly drained areas are considered wet or non-wet depending on their spatial and conceptual associates. Wet terrain is not divided further at the Ecosection level. Non-wet terrain is divided further on one or more of the following criteria, where appropriate in occurrence, extent, and homogeneity:

1. Calcareous *vs.* noncalcareous genetic materials.
2. Two of five textural groups that broadly define textural characteristics of genetic materials.
3. Four soil-vegetation classes that reflect geomorphic activity and mesoclimatic differences.

The first two criteria were also used to separate genetic material units (summarized in Table 5) even though each unit has more specific chemical and textural properties (see *Geomorphology*, Chapter I).

Calcareous vs. noncalcareous is a regrouping of the 14 classes used to describe the reaction and calcareousness of soil profiles (C.S.S.C. 1978b). Some major soil distinctions in the Rocky Mountains are associated with the two groups. Borderline situations, such as weakly calcareous materials with lime at considerable depth, were placed in either group, depending on factors such as extent, associated soil development, major lithological source, and vegetation. In KNP, weakly calcareous materials were most often placed in the noncalcareous group because of similar soil development and lithological source. Examples of Ecosections separated by calcareousness are PL (calcareous) *vs.* EG and LV (noncalcareous), all occurring on glacial materials in the Upper Subalpine. The latter two are separated by texture.

Five *textural groups* were devised to suit the map scale and concepts, and reflect major lithological sources and depositional agents. The five groups are defined relative to textural classes (C.S.S.C. 1978b):

1. Coarse: 60 to 100% sand and 0 to 10% clay, parts of the sandy loam, loamy sand, and sand textural classes.
2. Medium: 20 to 60% sand and 0 to 20% clay or, if <20% sand, % sand ≥ %clay; parts of the silt, silt loam, loam, and sandy loam textural classes.
3. Fine: 0 to 40% sand and 20 to 50% clay or, if <20% clay, % clay ≥ % sand; parts of the silt, silt loam, loam, silty clay loam, clay loam, silty clay, and clay textural classes.

Table 74. Organization of Ecosections by Ecoregion and genetic material.

Genetic Material	Montane	Lower Subalpine	Upper Subalpine	Alpine
Residual (including regolith)	—	—	—	HE
Landslide	—	IB	BP	—
Colluvial	DG	FV,SB	EN,WF,WH	BS,RD,TK
Glacial (morainal + ice contact stratified drift)	DR,WY	BY,CA,CV†	EG,LV,PL,SX†	EF,JN
Glaciofluvial	AT,(HD)*	BV,(PP)*	—	—
Fluvial (including fluviolacustrine)	FR,(HD)*,VL	AL,HC†,(PP)*	—	—

† Dominantly wet terrain.
* HD and PP are associated with two genetic material classes.

4. Stratified: layered material with vertical textural variability encompassing more than one of the above groups; coarse-stratified - variability mainly in the fine and medium groups.
5. Variable: a map delineation containing more than one of the above groups in unpredictable distribution.

Fig. 11 shows the coarse, medium, and fine groups on the textural triangle. Textures beyond these group limits rarely occur in KNP.

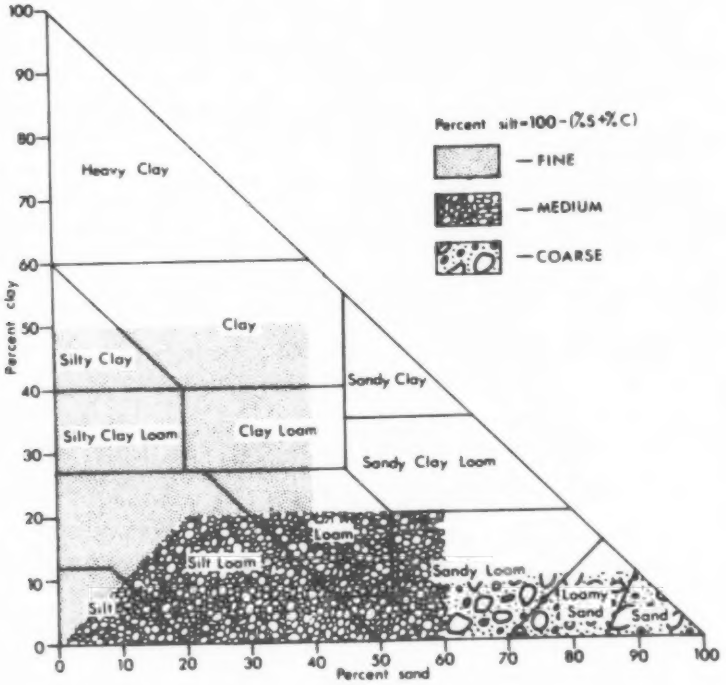
Genetic materials with textural properties controlled by mode of deposition are associated with certain of the above textural groups, *e.g.* fluvial materials are usually stratified, glaciofluvial materials are normally coarse and glaciolacustrine materials are generally fine textured. Textural characteristics of other materials are related to lithological sources (*e.g.* morainal materials). For these materials, the coarse and medium groups were used to define Ecosection separations (*e.g.* LV *vs.* EG Ecosections), since land areas of each group were of sufficient extent and homogeneity to be separated. Fine textured materials derived from fine grained bedrock occur in KNP but are mixed with medium textured materials. They were regrouped as medium to fine textured material and were used to distinguish some KNP Ecosections (DR) from similar ones in BNP and JNP (PT, Walker *et al.* 1982d).

Four *soil-vegetation* classes were devised to distinguish large and homogeneous land areas with differences in soil and vegetation development. These soil-vegetation differences reflect mesoclimate or recent geomorphic activity and define Ecosection separations within land areas not previously separated by calcareousness or textural criteria. The four classes used in KNP are similar in kind to the five classes distinguished for BNP and JNP (Walker *et al.* 1982b) and are defined as:

1. Land areas dominated by Regosolic soils and other soils with weak profile development on young and active landforms. A wide variety of v.t.s types are associated with these Regosolic soils.
2. Land areas dominated by Brunisolic and Podzolic soils and a variety of v.t.s types on older, more stable landforms.
3. Land areas dominated by Brunisolic soils with thin sola. Regosolic and Chernozemic soils are important associates but range from subdominant to minor in areal extent. Vegetation is mainly Douglas fir forest with subdominant to minor amounts of Douglas fir open forest and grassland.
4. Land areas dominated by Brunisolic soils with luvisolic tendencies. Subdominant Luvisolic soils and a variety of v.t.s are associated.

Classes 1 and 2 differentiate fluvial landforms with current or recent geomorphic activity (HD and PP Ecosections) from those with much older surfaces (FR and AL Ecosections). Soils on steep colluvial slopes also show differences related to the degree of activity but these are much more localized and are emphasized at the Ecosite level.

Fig. 11. Fine, medium and coarse textured groupings for genetic materials.



Classes 3 and 4 distinguish landscapes with different mesoclimates on calcareous, glacial landforms in the Montane. Class 3 represents soils and vegetation developed under warm, dry conditions in southwestern KNP (WY Ecosection). Class 4 soils and vegetation reflect moister, cooler conditions to the east in the Kootenay and Vermilion river valleys.

Ecosites

The 31 Ecosections are further separated into 78 Ecosites. Ecosites are named as numerical subdivisions of the Ecosection name, *e.g.* the Daer (DR) Ecosection is divided in to DR1 to DR8. There are one to eight Ecosites per Ecosection. Ecosites were separated on vegetational differences as well as differences in soil and landform. Factors controlling the choice of the following criteria include scale of mapping, reliability of photographic interpretation, and areal extent.

Physiognomic groups not previously separated at the Ecosection level were differentiated at the Ecosite level. The physiognomic groups are: a) closed forest, b) open forest, c) shrub, d) low shrub and herb, and e) herb. Such separations include DG3 *vs.* DG1 and DG2 (open *vs.* closed forests), VL2 *vs.* VL6 (shrub *vs.* open forest), SX1 *vs.* SX2 (low shrub and herb *vs.* open forest) and HD6 *vs.* HD5 (herb *vs.* closed forest).

Habitat groups of v.t.s types not previously used to separate Ecosections were used to separate Ecosites as follows:

1. Land areas with poplar (***Populus*** spp.) forest predominant (*e.g.* DR4 *vs.* other DR Ecosites).
2. Land areas with lodgepole pine (***Pinus contorta***) forest predominant (*e.g.* FR1 *vs.* FR3, AL4 *vs.* AL3).
3. Land areas with white spruce (***Picea glauca***), white spruce-Douglas fir (***Picea glauca-Pseudotsuga menziesii***) or mixedwood forest predominant (*e.g.* FR3 *vs.* FR1).
4. Land areas with Engelmann spruce-subalpine fir (***Picea engelmannii-Abies lasiocarpa***) forest predominant (*e.g.* AL3 *vs.* AL4).
5. Land areas with Douglas fir forest predominant (*e.g.* DR1 *vs.* other DR Ecosites).
6. Land areas with western red cedar (***Thuja plicata***) forest predominant (*e.g.* BY5 *vs.* other BY Ecosites).
7. Land areas with subalpine larch (***Larix lyallii***) forest predominant (*e.g.* WH1 *vs.* other WH Ecosites).
8. Land areas near timberline with a mosaic of heath tundra plus scattered subalpine larch trees, tree islands or krummholz predominant (*e.g.* EG4 *vs.* other EG Ecosites).
9. Land areas with avalanche complex (shrubs and herbs) predominant (*e.g.* WH7 *vs.* WH8).

These groups are useful in identifying wildlife habitat and sometimes correlate with soil and landform differences.

Complex map units include land areas comprised of two or more distinct but cartographically inseparable soil-vegetation or genetic material components and were separated as follows:

1. Land areas containing distinct aspect or exposure differences (flagged by *northerly vs. southerly* in the legend) with corresponding major differences in soil and vegetation, were separated from land areas comprised mainly of either end member (*e.g.* WY2 *vs.* WY1, DR5 *vs.* DR3 and DR1).
2. Land areas comprised of a distinct *dry* and *wet* pattern of soils and vegetation were separated from land areas comprised mainly of either end member (*e.g.* DR6 *vs.* DR3, DR8, *vs.* DR2 and DR7).
3. Land areas dominated by ice contact stratified drift were separated from land areas dominated by morainal deposits (*e.g.* BY4 *vs.* BY1, BY7 *vs.* BY3).
4. Land areas dominated by chemically complex genetic materials and labelled *calcareous > noncalcareous* were separated from land areas dominated by more homogenous calcareous materials (*e.g.* SB6 *vs.* SB2, SB7 *vs.* SB3).

Soil and vegetation differences used to define Ecosites were considered insufficient in magnitude or kind to warrant separations at the Ecosection level. An attempt was made to define repeating natural Ecosite concepts so that differences among central concepts are of equal magnitude. Having established this statement as a model, it is difficult to evaluate whether the diverse differentiating criteria, in aggregate, give the desired results.

As with any criteria defining cartographic concepts, individuals falling close to class boundaries may be more like each other than like the different central concepts with which they are classed. Thus, cartographic separations of a continuum always necessitate some arbitrary decisions as to which class a given individual may belong. The guidelines above are reasonably precise with regard to the central concepts of the classes and have resulted in a useful organization of the natural phenomena being mapped.

ECOLOGICAL (BIOPHYSICAL) LEGEND CORRELATION

Recent land inventory projects bordering KNP, and sometimes including parts of it, utilized varying degrees of ecological integration in their approaches. The KNP and BNP-JNP Ecological Land Classification legends are effectively parts of a single legend and were designed using the same philosophical principles and methodology. Thus, KNP map units are correlated with BNP and JNP units (Walker *et al.* 1982d) at the Ecosection level. Three other inventory legends have somewhat different designs. These are the soil resource reports of the Lardeau Map Area (Wittneben 1980) and East

Kootenay Map Area (manuscript maps and legend only, Lacelle 1982) and the biophysical inventory of Yoho National Park (YNP) (Coen and Kuchar 1982). The methodologies are compared below and the map units are correlated in Appendix C.

The two British Columbia Ministry of Environment studies are basically soil inventories (1:100,000 scale) with ecological land classification overtones, since the legends use forest zonation at the highest levels of generalization. The first two (Wittneben 1980) or three (Lacelle 1982) levels of classification, structure the landscape by physiographic or forest regions (Interior Wet Belt Region *vs.* Dry Interior Region), forest zones, and forest subzones. Classes within these hierarchical levels are based on climax tree species and successional sequences. KNP occurs in the Dry Interior Region (Rocky Mountain Trench and Rocky Mountain Area Physiographic Region) and was divided into three forest zones (Interior Douglas fir, Subalpine Engelmann spruce-alpine fir, and Alpine tundra) with boundaries which differ slightly between the two studies. The forest zones correspond conceptually to the three Ecoregions in the KNP and BNP-JNP ecological inventories but, in most cases, have significantly different boundaries. In the East Kootenay Map Area (Lacelle 1982) the forest zones of the Dry Interior Region were divided into seven forest subzones which resulted in a proliferation of map units.

Forest zones and subzones were divided into soil associations which form the basis of the soil mapping and were given geographic names. Criteria for soil association separations are based on genetic material classes (six mineral, one organic), deep *vs.* shallow deposits (non-lithic *vs.* lithic phases), various bedrock lithology groups, and dominant soil development expressed by classification to the subgroup or great group levels. Soil associations, therefore, correspond approximately to Ecosections in the KNP, BNP and JNP ecological inventories but the criteria and classes for separations differ significantly for many landscapes. Further, some criteria (*e.g.* parent material thickness) are applied at the next lower level of classification in the KNP and BNP and JNP inventories. Limits for soil association separations appear to be broader for high elevation landscapes (*e.g.* Alpine tundra) than for lower elevation zones and subzones. Differences in soil taxonomy are due to differing interpretations of field characteristics and, more importantly, use of older versions of the Canadian soil taxonomy in at least one study (Wittneben 1980).

Soil associations were divided into soil association components (soil association name plus a number) which are the basic map units. These are differentiated according to the proportions of subgroups within the soil association. The subgroups are related but differ due to local variations in soil depth, drainage, texture, and aspect. These criteria and those which differentiate Ecosites in the KNP and BNP and JNP inventories differ considerably.

Another major difference between the British Columbia soil surveys and the KNP and BNP-JNP inventories concerns legend form and mapping procedure. The two soil surveys utilized an uncontrolled legend (Mapping Systems Working Group 1981) and each map delineation was identified with up to three soil association components resulting in a compound map unit. The number of possible combinations is very high and many delineations may be unique. The KNP and BNP-JNP inventories uses a controlled legend (Mapping Systems Working Group 1981) and a simple map symbol.

The YNP biophysical inventory (Coen and Kuchar 1982) is a marriage at a scale of 1:50,000, of independent soil (Coen *et al.* 1977) and vegetation (Kuchar 1978) inventories of 1:25,000 scale. As in the KNP and BNP-JNP inventories, the YNP inventory used a controlled legend. Map unit symbols were hyphenated with the first part indicating dominant soilscape group (Coen *et al.* 1977) and the second element denoting vegetation type or grouping (Kuchar 1978). Map units were organized, in the legend, under vegetation zones which, with one exception, are conceptually similar to Ecoregions in the KNP and BNP-JNP inventories. Boundaries differ slightly in some cases and the YNP biophysical inventory has an additional zone, the Montane-Subalpine. Hierarchical levels in the YNP legend are fewer than in the KNP and BNP-JNP legends. The YNP legend has no Ecosection level or facsimile because the soilscape group separations, although based on landform, parent material and soil classification criteria similar to those for Ecosections, disregard vegetation zones. Nevertheless, YNP biophysical map units are similar to KNP Ecosections in concept and the two legends are correlated at this level of classification (Appendix C). Differences in soil taxonomy between correlated map units are mainly due to the use of an older version of the Canadian soil classification system for the YNP biophysical inventory.

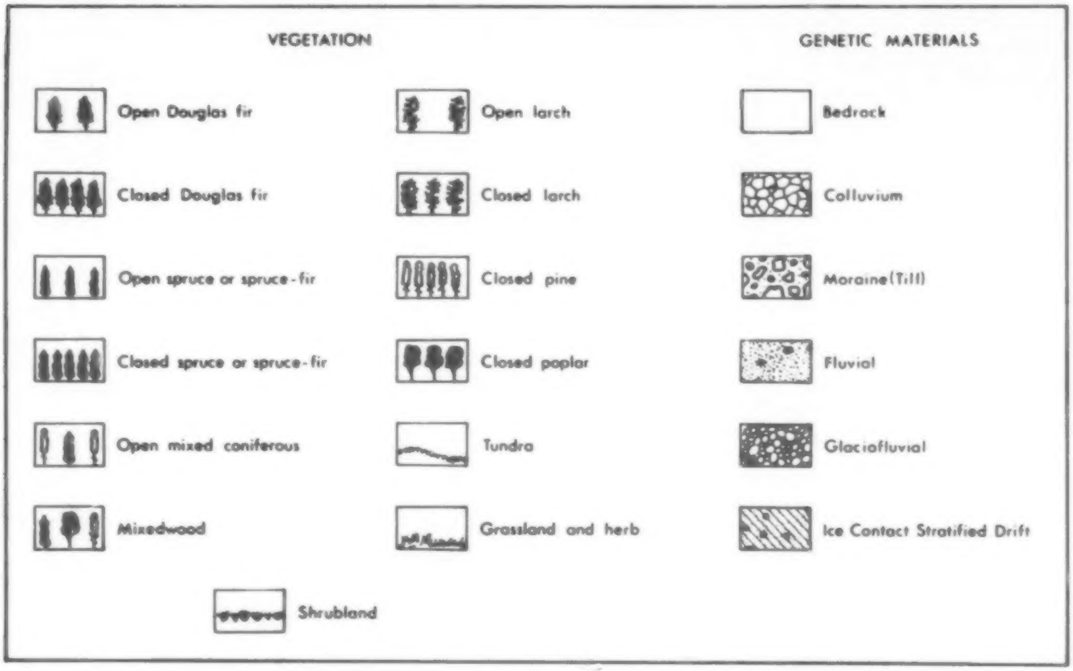
DESCRIPTION OF ECOSECTIONS/ECOSITES

B.D. Walker, W.S. Taylor, P.L. Achuff, D.M. Poll, D.T. Allan and M.M. Porter

INTRODUCTION

A comprehensive discussion of each mapping concept used in the KNP Ecological Land Classification is provided in this section. The descriptions are arranged alphabetically by Ecosection symbol. Fig. 12 provides a legend for the schematic, cross-sectional diagrams. Appendix D contains pedon descriptions cited in the following Ecosection accounts as, for example, Table D1.

Fig. 12. Legend for landscape schematics.


VEGETATION
Open Douglas fir
Closed Douglas fir
Open spruce or spruce-fir
Closed spruce or spruce-fir
Open mixed coniferous
Mixedwood
Open larch
Closed larch
Closed pine
Closed poplar
Tundra
Grassland and herb
Shrubland
GENETIC MATERIALS
Bedrock
Colluvium
Moraine (Till)
Fluvial
Glaciofluvial
Ice Contact Stratified Drift

A ***Discussion and Management Considerations*** section for each Ecosection deals with mapping concept similarities between the KNP and BNP and JNP inventories, distinguishes similar landscapes within KNP, and highlights important features that may affect park uses. The statements are intended to broadly indicate potential suitability or limitation. Due to scale and local variation, each tract should be evaluated in detail for specific proposed uses.

AL - ALTRUDE ECOSECTION

The Altrude (AL) Ecosection concept includes: Lower Subalpine forest vegetation, fan and apron landforms composed of calcareous fluvial material and well to moderately well drained Eutric Brunisols. Two AL Ecosites (Table 75) were differentiated primarily by Engelmann spruce-subalpine fir *vs.* lodgepole pine forest. AL occurs on lower slopes and floors of broad valleys in the Main Ranges. Fig. 16 shows AL3 relative to some other Ecosites.

GEOMORPHOLOGY

Fluvial material B (calcareous, coarse-stratified) is the main constituent of AL landforms. The lime content varies greatly between landforms and sites. In KNP, low lime contents (about 5-40% calcium carbonate equivalent) are most extensive due to mixing, during fluvial deposition, of calcareous and noncalcareous materials derived from adjacent valley walls. Fluvial material A (noncalcareous, coarse-stratified) occurs infrequently and only in a few AL tracts. Eolian material B (altered, medium textured) occurs occasionally in AL landforms as a thin, discontinuous veneer or, more often, as an eolian-fluvial material mixture generated by erosional and disturbance processes.

Fans and aprons with straight to concave slopes (2-30%) characterize the landform surface expression. Mid to lower solum layers exhibit a till-like material indicative of mudflow deposition, thought to be an important process in fan and apron construction. Other, more sorted layers are usually associated with fluvial deposition and some tracts include level and terraced landforms constructed by flowing water. Tracts with complex slopes contain both fan/apron and level fluvial landforms or, less often, have fluvial veneers and blankets overlying other deposits. Slope continuity is often subtly broken by stream channels (Eroded modifier, C.S.S.C. 1978a), including narrow, elevated ridges along the banks.

SOILS

AL is characterized by well to moderately well drained soils with pedogenic horizons indicating weathering of old, stable, landform surfaces. The dominant Eutric Brunisols, with mildly acid to neutral BC and lower B horizons, reflect calcareous parent material. Soils with more acidic lower sola (Dystric Brunisols) also occur due to deeper weathering of carbonate in conjunction with lower initial carbonate content. Occasionally, stronger weathering, particularly where Eolian material B occurs in upper sola, produces Orthic Humo-Ferric Podzols. Ae horizons may be present (Eluviated subgroups where Ae $\geq$2 cm thick) or absent (Orthic subgroups). Absence is associated with disruptive processes and Orthic Eutric Brunisols are more abundant on AL4 than AL3, possibly because of post-fire erosion. A pedon illustrating characteristics of AL soils (Table D1, Plate 3) is from an AL4 tract near the Vermilion River-Hawk Creek confluence. Although an Eluviated Eutric Brunisol, its low pH and thin Bf horizon make it close to both Eluviated Dystric Brunisols and Orthic Humo-Ferric Podzols.

Minor soils include Orthic and Cumulic Regosols which are restricted to narrow strips along stream channels and may be eroded or flooded during spring run-off and periods of high precipitation.

VEGETATION

AL3 is characterized by Engelmann spruce-subalpine fir forest with Engelmann spruce-subalpine fir/false azalea (C14) dominant. C14 grades towards the white spruce/buffaloberry/feathermoss (C37) v.t. on low elevation tracts in the Vermilion River valley and occasionally has a more open tree canopy than normal. Some C14 stands approach the lodgepole pine/false azalea/grouseberry (C20) v.t. because of lodgepole pine in the tree canopy. A rare v.t., Engelmann spruce-subalpine fir/devil's

Table 75. Definitive features of Altrude (AL) Ecosites.

Ecosite	Landform	Soils	Vegetation
AL3	Fluvial material B; apron & fan	Eluviated Eutric Brunisol > Eluviated Dystric Brunisol	Engelmann spruce-subalpine fir forest (C14)
AL4	Fluvial material B; apron & fan	Orthic & Eluviated Eutric Brunisols > Eluviated Dystric Brunisol	lodgepole pine forest (C20)

club/fern (C40), occurs on an AL3A tract in Vérendrye Creek valley. AL3A tracts have 20 to 50% of the area modified by snow avalanching. Modification is mainly to vegetation producing avalanche v.t.s such as green alder/fern (S13), subalpine fir-willow (S2), and fireweed-meadow rue (H22) on avalanche paths.

AL4 is characterized by lodgepole pine forest with lodgepole pine/false azalea/grouseberry (C20) the dominant v.t. Many stands on AL4 along the western base of Hawk Ridge have unusually open canopies, probably due to tree kill by mountain pine beetle over 50 years ago. Two AL4B tracts near Vermilion Pass are dominated by lodgepole pine/twinflower-fireweed (S5) and related post-fire vegetation because of the 1968 burn in that area.

WILDLIFE

AL3 Wildlife Features

Ungulates: AL3 is highly important to moose year round and moderately important to elk in summer, particularly where associated with Highway 93. Ungulate browsing was moderate. Most commonly browsed were false azalea (***Menziesia glabella***), rhododendron (***Rhododendron albiflorum***), tall bilberry (***Vaccinium membranaceum***) and willows (***Salix*** spp.).

Carnivores: Although of low importance overall, AL3 is moderately important to coyotes and martens all year.

Small Mammals: Association 2.

Red-backed voles occur here in high numbers while deer mice are moderately abundant. High use by porcupines was recorded and moderate use by snowshoe hares.

Breeding Birds: Community 8.

A high density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Golden-crowned Kinglet, Chipping Sparrow, Townsend's Warbler, Yellow-rumped Warbler, Brown Creeper and Swainson's Thrush.

AL4 Wildlife Features

Ungulates: This Ecosite is of high importance to elk in summer and fall, especially where associated with Highway 93 and in the Vermilion Pass burn with S5 v.t.

Carnivores: AL4 is of low importance except in the Vermilion Pass burn where very high densities of martens occur.

Small Mammals: Associations 3 and 9.

A low number of species occurs here in moderate numbers. Red-backed voles, snowshoe hares and red squirrels are most common.

Table 76. Wildlife features of AL Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
AL3	medium	moose	low		medium	porcupine red-b. vole	high
AL4	low	elk	low		low	dusky shrew red-b. vole	low

Breeding Birds: Communities 5 and 21.
A low density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Lincoln's Sparrow.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The AL Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and applied to similar landscape (1.2%) in KNP. Two new Ecosites, AL3 (0.7%) and AL4 (0.5%), were recognized to better accommodate the subdominant Dystric Brunisols and conifer/false azalea forests (C14 and C20), which indicate a lower lime parent material and moister climate in KNP than BNP and JNP. In BNP and JNP AL1 and AL2 are characterized only by Orthic and Eluviated Eutric Brunisols occurring under lodgepole pine/buffaloberry/twinflower (C19), Engelmann spruce-subalpine fir/feathermoss (C13), and Engelmann spruce-subalpine fir/hairy wild rye-heartleaf arnica-twinflower/feathermoss (C31) forests.

AL is the Lower Subalpine counterpart of the Montane Fireside (FR) Ecosite. Pipestone 3 (PP3) resembles AL3 but occurs on fluvial landforms with significantly younger surfaces as indicated by Regosolic soils on PP3. Some Hector 1 (HC1) tracts may be similar to AL3, but HC1 usually has wetter soils and open forest vegetation indicative of periodically high water tables.

AL tracts with gentle slopes generally have no landform, soil, or vegetational characteristics limiting to campground, trail, or related uses. Locally occurring coarse textures and high water tables may present problems for sewage disposal. But the gravelly coarse textured material is suitable aggregate for construction. Most tracts have streams that are suitable domestic water supplies. Exceptional floods and mudflows may occur, although soil development indicates stability.

Fluvial fans such as AL are key areas of ungulate use and have high breeding bird densities in mixedwood forests.

AT - ATHABASCA ECOSECTION

The Athabasca (AT) Ecosection concept incorporates: Montane forest vegetation, terraced landforms of Glaciofluvial material B (calcareous, coarse textured), and well to moderately well drained Eutric Brunisols. The two Ecosites are separated primarily by vegetational differences (Table 77). Fig. 18 shows AT1 with other Montane Ecosites.

Table 77. Definitive features of Athabasca (AT) Ecosites.

Ecosite	Landform	Soils	Vegetation
AT1	Glaciofluvial material B; terraced	Orthic Eutric Brunisol	lodgepole pine forest (C38)
AT4	Glaciofluvial material B; fluvial veneer over terraced	Orthic & Eluviated Eutric Brunisols	white spruce forest (C37)

GEOMORPHOLOGY

AT1 and AT4 occur on the floor of the Kootenay, Vermilion and Simpson river valleys. The landforms are Glaciofluvial material B (calcareous, coarse textured). Finer textured veneers, low in coarse fragments, mantle some terraces, particularly in AT4. Veneers most often resemble Fluviolacustrine material B (calcareous, coarse-stratified), occasionally Fluviolacustrine material B (calcareous, fine-stratified) and infrequently, Eolian material B (altered, medium textured). The mode of surficial deposition is not certain.

AT tracts have simple or complex slopes, with slopes ≤15% most common. Treads make up a majority of the terraces and have linear, gentle slopes in contrast to the short steep risers. Portions of some AT tracts retain an irregular channeled surface (Eroded modifier, C.S.S.C. 1978a) from the braided streams that formed them during deglaciation.

SOILS

Long term landform stability is reflected in the uniform soil development on AT1 and AT4. AT soils are well to moderately well drained Eutric Brunisols. Orthic Eutric Brunisols predominate on AT1, while both Orthic and Eluviated Eutric Brunisols dominate AT4. The taxonomic separation is based on depth of the surface eluvial (Ae) horizon in these otherwise similar soils. The sampled pedon (Table D2, Plate 4) is from an AT1 tract at the confluence of the Kootenay and Vermilion rivers. Textures in this profile are finer than modal for glaciofluvial materials and resemble some fluvial materials. Landscape position plus the influence of argillaceous bedrock and fine textured, surficial source materials likely contributed to the finer textures.

Localized turbic phases result from infrequent windthrow of trees. Soil inclusions are Orthic Gray Luvisols associated with fine textured veneers on AT4, Gleyed Eutric Brunisols on seasonally high water table sites on AT4, and Orthic and Cumulic Regosols associated with recent fluvial veneers and recently abandoned stream channels along major rivers.

VEGETATION

AT1 is characterized by lodgepole pine forest with lodgepole pine/buffaloberry/pine grass (C38) as the dominant v.t. (Plate 5). Lodgepole pine/juniper/bearberry (C3) on dry sites and lodgepole pine/buffaloberry/bunchberry (C39) are accessory v.t.s.

AT4 is charcterized by white spruce forest with white spruce/buffaloberry/feathermoss (C37) dominant. Accessory v.t.s include white spruce-Douglas fir/feathermoss (C5) and spruce-aspen-lodgepole pine-(paper birch)/buffaloberry/pine grass (C44).

WILDLIFE

AT is highly important to wildlife, particularly as ungulate winter range.

AT1 Wildlife Features

Ungulates: AT1 has high importance to elk in winter and moderate importance to white-tailed deer in summer. Low browse use in these lodgepole pine (*Pinus contorta*) v.t.s suggests that their importance is as cover, particularly tracts adjacent to the grassy right-of-way of Highway 93. AT1 is also used extensively by elk and white-tailed deer to travel between winter and summer ranges.

Carnivores: AT1 is highly important to large carnivores: wolves, coyotes and cougars. The abundance of prey species and relatively easy winter travelling conditions make this Ecosite highly important. Wolves made moderate use of AT1 during the winter of 1982-83.

Small Mammals: Associations 1 and 2.
Deer mice, red-backed voles and red squirrels are the commonest species. Snowshoe hares and Columbian ground squirrels occur in moderate numbers.

Breeding Birds: Communities 1 and 19.
A medium density of birds was recorded. Species diversity is high. Based on density indices derived from circular census plots, this Ecosite is highly important to Spruce Grouse, Swainson's Thrush, and Yellow-rumped Warbler.

AT4 Wildlife Features

Ungulates: AT4 is highly important to moose and elk in winter and white-tailed deer in summer. Use is particularly high where associated with FR3 and HD6 and manmade grassland areas along Highway 93 and the McLeod Meadows area. Ungulate browsing was high in all v.t.s. Heaviest use was recorded on saskatoon (*Amelanchier alnifolia*), willow (*Salix* spp.) and false azalea (*Menziesia glabella*) in C37; mountain maple (*Acer glabrum*), willow, red-osier dogwood (*Cornus stolonifera*) and aspen (*Populus tremuloides*) in C44; and red twin-berry (*Lonicera utahensis*) and currants (*Ribes* spp.) in C5.

Carnivores: The importance of AT4 is high, especially in winter. Prey availability is high year round as is availability of carrion from road kills, particularly during winter. Coyotes make heavy use of these areas all year and wolves made regular use during the winter of 1982-83.

Small Mammals: Associations 2 and 3.
High numbers of red-backed voles and red squirrels occur here. AT4 is also important to beavers.

Breeding Birds: Communities 1, 5 and 19.
A high density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Western Wood Pewee, Vesper Sparrow, Lincoln's Sparrow, Olive-sided Flycatcher, Chipping Sparrow, and Black-capped Chickadee.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The AT Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and applied to similar landscapes (1.3%) in KNP. Likewise, AT1 (0.6%) was extended, with slight modification to the vegetational component, to KNP. AT4 (0.7%) was defined to describe white spruce forest in KNP.

Table 78. Wildlife features of AT Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
AT1	medium	elk	high	wolf coyote cougar	medium	red squirrel deer mouse red-b. vole	medium
AT4	high	moose elk deer	high	wolf coyote cougar	medium	red squirrel red-b. vole beaver	high

AT is the Montane counterpart of the Lower Subalpine Bow Valley (BV) Ecosection. Fireside (FR) often adjoins and resembles AT, but occurs on fans and aprons of Fluvial material B (calcareous, coarse stratified).

Level topography and valley floor positions are conducive to many uses. Gravelly coarse textures provide extensive aggregate supplies but are poor for sewage disposal due to poor ion filtration. Revegetation may be slow because of seasonal droughty conditions.

AT is very important to wildlife especially ungulates and carnivores. Critical ungulate habitat occurs particularly where associated with VL2 and HD6. Raptors frequent open sites. High bird densities occur in mixedwood forests.

BP - BOULDER PASS ECOSECTION

The Boulder Pass (BP) Ecosection concept comprises landslide deposits dominated by Upper Subalpine vegetation. Only one BP Ecosite (BP2, Table 79) was differentiated and only one tract occurs in KNP. It is a distinctive, prominent, blocky landscape stretching westward along the valley floor from Goodsir Pass into YNP (Plate 6) where it was mapped as SI-aL (LS) by Coen and Kuchar (1982).

GEOMORPHOLOGY

The landslide forming the hummocky landform is likely due to failure of Ottertail Formation limestone high on the slope of Sharp Mountain. The texture reflects massive bedrock and its disintegration due to cataclysmic failure. Large limestone blocks (coarse fragments >256 mm) are characteristic, although there are a few crystalline fragments from the Ice River alkaline complex which caps Sharp Mountain. Calcareous, medium textured fine earths and rubble occur in the weathering zone but usually disappear within 1 m leaving fragmental material with large voids. Much of the fine earth material is Eolian material B (altered, medium textured) or derivatives reworked by slope wash and solifluction. This silty material forms a thin, discontinuous veneer among the large blocks and the ground surface remains exceedingly to excessively stony (C.S.S.C. 1978b).

The hummocky surface reflects landform genesis rather than bedrock control. Slopes are highly complex, of various length and from 15 to 30%. Morainal material probably underlies the landslide, although parts of the Goodsir Pass landslide resemble an extinct rock glacier. The age of the landslide is therefore uncertain.

Table 79. Definitive features of Boulder Pass (BP) Ecosites.

Eco-site	Landform	Soils	Vegetation
BP2	Landslide material; eolian veneer over hummocky landslide	Orthic Eutric Brunisol, Orthic Humo-Ferric Podzol	subalpine larch-subalpine fir forest (C23), subalpine larch open forest (O13) > Engelmann spruce-subalpine fir forest (C21)

SOILS

The BP Ecosection concept, as it applies to landslides in KNP, BNP and JNP, includes rapidly to moderately well drained Regosolic, Brunisolic, and Podzolic soils plus minor amounts of nonsoil. This diversity is primarily a function of calcareousness and fine earth content of the parent materials plus time over which pedogenic forces have been acting in the soil. The BP2 tract in KNP is dominated by well drained Brunisolics and Podzolics which are comparatively well developed because of the widespread occurrence of Eolian material B veneer. Bm horizons (Eutric Brunisols) with or without thin Bf horizons, tend to develop where the veneer is thin. Orthic Humo-Ferric Podzols with podzolic Bf horizons overlying neutral sola, (Table D3), occur where the veneer is thicker. Ae horizons are generally absent (Orthic Eutric Brunisols) on this BP tract, except perhaps under spruce-fir forest at lower elevations. Thin Ah horizons are often present at higher elevations under larch forest. In some larch open forest, Ah horizons are occasionally ≥10 cm thick (Orthic Melanic Brunisol). The occasional occurrence of Bhf horizons also shows that upper sola are humus-rich.

Turbic phases occur where upper horizons have been contorted and mixed by solifluction or some other process (Table D3). Sparsely vegetated and unvegetated sites (Plate 7) often have little or no silty veneer and the soils are thus Regosolic or weakly developed Brunisolic. Fine earth material is absent at many unvegetated sites and the fragmental material is nonsoil.

VEGETATION

BP2 is characterized by v.t.s in which subalpine larch is dominant. Subalpine larch-subalpine fir/grouseberry-everlasting (C23) is most extensive across the central portion of the tract (Plate 8). However, the tree canopy opens up to the subalpine larch-subalpine fir/heather (O13) v.t. at higher elevations and near sparsely vegetated sites. Many sites, at lower elevations along the YNP border, are dominated by spruce-fir forest, mainly the Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) v.t., with lesser amounts of Engelmann spruce-subalpine fir/grouseberry (C15).

WILDLIFE

BP2 Wildlife Features

Ungulates: The only BP2 tract occurs at Goodsir Pass and has low summer use by elk and mountain goats.
Carnivores: BP2 is of low importance.
Small Mammals: Association 5.
BP2 has high densities of hoary marmots, least chipmunks and porcupines.

Table 80. Wildlife features of BP Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
BP2	low		low		high	porcupine marmot least chipmunk	high

Breeding Birds: Communities 7 and 8.

A high density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to White-tailed Ptarmigan, Mountain Chickadee, Rosy Finch, Yellow-rumped Warbler and Pine Siskin.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The BP Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and applied to similar landscape (0.1%) in KNP. BP2 in KNP (0.1%) is confined to one tract and is a subset of the broader BP2 concept of BNP and JNP. The BP2 tract contains sparsely vegetated to unvegetated localities that resemble BP1 of BNP and JNP but these are too small to map.

No other landscapes in KNP closely resemble BP2. The PL4F tract adjacent to the BP2 at Goodsir Pass has similar stoniness and irregular topography but occurs on a morainal landform that was once a rock glacier.

Use is limited by rubbly, blocky surfaces and irregular topography. Vegetation will recover slowly from disturbance. It is important for hoary marmots and pikas and has a high bird density.

BS - BOW SUMMIT ECOSECTION

The BS Ecosection concept incorporates landforms composed predominantly of calcareous colluvium, well drained Brunisolic and Regosolic soils, and Alpine tundra vegetation. Two BS Ecosites (Table 81) are differentiated mainly by landform and soil features.

BS occupies upper to highest elevations on steep valley walls throughout KNP, usually in close association with calcareous bedrock. Most BS landscapes are likely postglacial. Figs. 13 and 22 illustrate the landscape relationships between the BS and other Ecosites.

GEOMORPHOLOGY

Colluvium C (calcareous, medium textured) is the predominant genetic material characterizing the BS Ecosite. BS1 is restricted to consistently calcareous areas of the Main Ranges and is usually underlain by resistant carbonate bedrock. Colluvium C is by far predominant in BS1.

BS2 occurs in the lithologically intricate Western Ranges (Fig. 2) and is also dominated by calcareous colluvium but includes Colluvium D (calcareous, fine textured) in addition to Colluvium C. A third material, Colluvium B (non- to weakly calcareous, medium textured), is locally important and of

Fig. 13. Landscape schematic of topographic relationships among BS, SB and WF Ecosites.

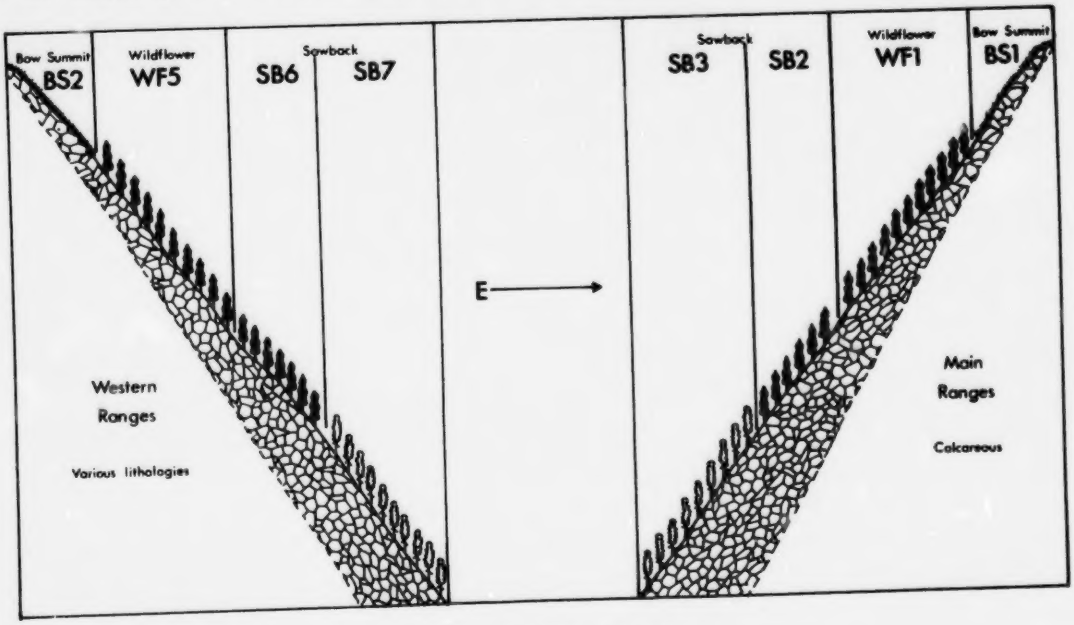


Table 81. Definitive features of Bow Summit (BS) Ecosites.

Eco-site	Landform	Soils	Vegetation
BS1	Colluvium C; blanket & veneer over inclined bedrock	Orthic Eutric Brunisol, Orthic Melanic Brunisol, Orthic Regosol, Orthic Humic Regosol	avens tundra (H1)
BS2	Colluvium C & D > B; blanket & veneer over inclined bedrock	Orthic Eutric Brunisol, Orthic Humic Regosol > Orthic Dystric Brunisol	avens tundra (H1), herb tundra (H17)

sufficient extent to be the subdominant genetic material unit of BS2 (Table 81). Intergrades among the three colluvial materials also occur. The colluvium in BS2 occasionally overlies a veneer of weathered bedrock if the bedrock is inherently soft. The veneer may be Residuum A, B or C, depending on the calcareousness and texture, and there is often a correspondence between the characteristics of the residuum and the overlying colluvium. Textures of both are usually medium to fine.

The colluvium occurs most frequently as uniform blankets or veneers, the thinner of which only subtly mask the underlying bedrock surface. Long, straight inclines are typical, but complex slopes are common near ridge crests and on shoulders, or where the colluvium is interspersed with rugged bedrock outcrops. Slopes are 45 to 100% and average 55 to 80%. Materials colluviate readily in the Alpine environment, as indicated by the slope of one BS1 tract on Boom Mountain which averages 30 to 45%.

Usually, eolian material on BS tracts has been mixed with colluvium by surface erosional processes. There is often exposed mineral soil which is subject to wind erosion.

Snow avalanching can occur on any BS tract. However, the degree and extent varies since there is seldom a difference in soils or vegetation between avalanched and unavalanched tracts. The avalanching modifier A is included parenthetically in the legend for both BS Ecosites.

Solifluction modifies surfaces, especially in BS2. A more limited amount of cryoturbation also occurs. Both processes influence soil and vegetation patterns.

SOILS

Most soils of the BS Ecosection are moderately well to well drained Brunisolics or Regosolics (Table 81). Orthic Eutric Brunisols are common in BS throughout the park on calcareous colluvium where stability has been sufficient for soil development ($\geq$ 1000 years). These Orthic Eutric Brunisols usually have: an absence of or restricted (<10 cm) A horizons into which organic material (Ah) has been physically incorporated, B horizons that are weakly to moderately developed (little extractable iron and aluminum) and 5 to 30 cm thick, and C horizons that are moderately to extremely calcareous. Lower sola have a medium acid to mildly alkaline reaction (pH >5.5). Other characteristic soils are interspersed with and usually related to the Orthic Eutric Brunisols.

Orthic Melanic Brunisols typical of BS1, and accessory on BS2, have a morphology similar to the Orthic Eutric Brunisols, except that the Ah horizon is >10 cm. Orthic Humic Regosols typical of both BS1 and BS2 have this same thick Ah horizon, but lack significant B horizon development.

Other Regosolic soils are common on the consistently highly calcareous colluvium of BS1 in the Main Ranges. Geomorphic disturbances often retard soil development by exposing or incorporating fresh calcareous material into the solum. Orthic Regosols, soils with little or no A or B horizon development, are typical of BS1. Cumulic Regosols and Cumulic Humic Regosols are accessory soils on BS1 and have various amounts of organic material incorporated into the otherwise undeveloped solum.

Acidic profiles develop on the noncalcareous portions of the colluvium (Colluvium B) in BS2. Orthic Dystric Brunisols, which form the minority element in BS2, differ from the Orthic Eutric Brunisols to the extent that the B horizons are strongly to very strongly acid (pH 4.5-5.5), even in the lower solum. The accessory Orthic Sombric Brunisols are similarly acidic, but also have $\geq$10 cm of Ah.

B horizons of these soils occasionally have modest amounts (1-5%) of organic carbon, which has probably been physically incorporated. When the amount of extractable iron is quite low, these horizons meet most of the criteria for a Bh horizon except that color values and chroma are too high. Since the environment is drier and the vegetation atypical of Humic Podzols, they are not designated Bh (C.S.S.C. 1978a), but rather Bm, resulting in the Brunisolic classification.

Colluvial veneers in BS are often shallow, especially on upper slopes. Lithic phases are accessory characteristics of both BS1 and BS2. Solifluction and cryoturbation are more common on BS2 and create turbic phase pedons which are an accessory characteristic.

A pedon illustrating BS soils (Table D4, Plate 9) is from a BS2 tract above Kindersley Creek and has features typical of BS in the Western Ranges. The landform is soliflucted and the pedon is correspondingly a turbic phase. The colluvium is inherently low in lime and thus the solum has pH's near the acidic limit of a Eutric Brunisol. Some horizon textures are medium, while others, though close in constituent values, are fine.

VEGETATION

The characteristic v.t.s of each BS Ecosite are in Table 81. The mountain avens-snow willow-moss campion (H1) v.t. occurs on both BS1 and BS2 throughout the park. It occurs most consistently at elevations well into the Alpine on calcareous materials. On BS2, H1 is codominant with the everlasting-grouseberry (H17) v.t. H17 is more common on sites transitional to Upper Subalpine, low in lime, fine textured, snow avalanched or some combination of the above (Plate 10).

The heather-everlasting (L5) is an accessory v.t. of both Ecosites. It occurs as patches at elevations transitional to the Upper Subalpine or in areas of late snow lie, and is usually associated with soils having strongly developed horizons. BS2, more diverse vegetationally than BS1, also has arctic willow-cinquefoil (L7) as an accessory v.t. Unvegetated localities (<20% cover) are an accessory characteristic of BS and can be extensive.

WILDLIFE

BS1 Wildlife Features

Ungulates: BS1 is of low importance to ungulates except mountain goats. Goat use is high in the summer and moderate in winter particularly in windblown, snowfree areas.

Carnivores: BS1 is of low importance.

Small Mammals: Associations 1 and 5.
BS1 is of moderate importance. Pikas and hoary marmots occur here at high densities.

Breeding Birds: Communities 17 and 18.
A low density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to White-tailed Ptarmigan and Water Pipit.

BS2 Wildlife Features

Ungulates: BS2 occurs predominantly in the Western Ranges (Brisco and Stanford ranges) and is highly important to mountain goats in summer and moderately so in winter. In the Kindersley-Sinclair area, it is very highly important to bighorn sheep in summer.

Carnivores: As with other Alpine Ecosites, BS2 is of low importance to carnivores. A cougar track was recorded in BS2 on Sinclair in June 1982.

Small Mammals: Associations 1 and 5.
BS2 is of moderate importance to small mammals. High numbers of pikas and hoary marmots occur here.

Breeding Birds: Community 18.
A low density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Water Pipit and Rosy Finch.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The BS Ecosection concept originated with the BNP and JNP inventory (Walker *et al.* 1982d) and has been extended to KNP. BS2 was added for KNP because of the range of textures and calcareousness in the Western Ranges and the diversity in vegetation and soils.

Table 82. Wildlife features of BS Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
BS1	low	goat	low		medium	pika marmot	low
BS2	medium	goat sheep	low		medium	pika marmot	low

BS accounts for 0.8% of KNP, with BS1 being 0.2% and BS2 0.6%. Wildflower (WF) is the Upper Subalpine counterpart since both occur on predominantly calcareous colluvium. BS most closely resembles the Redoubt (RD) Ecosection but the latter occurs on noncalcareous rather than calcareous colluvium and has predominantly acidic soils. The dominantly noncalcareous parent material of RD2 distinguishes it from BS2 which is dominantly composed of calcareous parent materials with only small, unmappable areas of noncalcareous parent materials. The Alpine Tekarra (TK) Ecosection can be distinguished from BS because the colluvium in TK is noncalcareous and coarse textured.

Use is limited by steepness and colluviation. Removal of vegetation may increase erosion and revegetation will be slow.

BS is important to mountain goats and sheep mainly as summer range, but also provides winter range for mountain goats since it is often blown snow-free. High densities of pikas, golden-mantled ground squirrels, and hoary marmots occur here.

BV - BOW VALLEY ECOSECTION

The Bow Valley (BV) Ecosection concept incorporates: Lower Subalpine forest vegetation, terraced landforms of Glaciofluvial material B (calcareous, coarse textured) and well drained Eutric Brunisols. Table 83 outlines the single BV Ecosite. Fig. 14 shows the relationship of BV to other Ecosites.

GEOMORPHOLOGY

BV2 occurs on the valley floor of the Vermilion River. The terraced landforms are composed of Glaciofluvial material B (calcareous, coarse textured).

BV2 tracts have simple or complex slopes of 0 to 15%. Straight, gently sloping terrace treads make up a majority of each tract. These contrast with short, steep risers between terrace levels, which are more pronounced on complex slopes. Portions of some BV tracts retain an irregular channeled surface (Eroded modifier, C.S.S.C. 1978a) from the braided streams that formed them during deglaciation.

SOILS

Long term landform stability and a narrow range of parent materials are reflected in the uniform soil development on BV2. Soils are Eluviated Eutric Brunisols. BV2 soils are well drained because of the porous nature of the glaciofluvial material. Also, the terraced surfaces are generally elevated well above the water table. The only disturbance to soils is infrequent windthrow of trees that creates localized turbic phases.

Table 83. Definitive features of Bow Valley (BV) Ecosites.

Eco-site	Landform	Soils	Vegetation
BV2	Glaciofluvial material B; terraced	Eluviated Eutric Brunisol	lodgepole pine forest (C20)

VEGETATION

BV2 is characterized by the lodgepole pine/false azalea/grouseberry (C20) v.t. A deviation from the modal C20 v.t. occurs near Vermillion Pass on a BV2B tract where early post-fire vegetation (lodgepole pine/twinflower-fireweed (S5)) is recorded. Another deviation occurs on the lowest elevation BV2 tract, near Vermilion Crossing which has vegetation transitional between the Lower Subalpine C20 and Montane lodgepole pine/buffaloberry/bunchberry (C39) v.t.s. At this site, besides *Menziesia glabella*, the shrub layer also contains *Shepherdia canadensis* and other shrubs and the herb-dwarf shrub layer is more diverse than normal for C20. The tree layer is a mixture of lodgepole pine (*Pinus contorta*), Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*) and a few sites are dominated by spruce.

WILDLIFE

BV2 Wildlife Features

Ungulates: The only two BV2 tracts with C20 v.t. are in the upper Vermilion Valley and are of moderate importance to moose in winter and of high importance to elk in winter since these are the only areas where elk over-winter in the upper Vermilion Valley. The third BV2 tract occurs in the Vermilion Pass burn near the Continental Divide and ranks high for moose and elk year round, primarily as a result of the S5 v.t.

Carnivores: BV2 is of low importance overall, however it is moderately important to martens and coyotes in winter.

Small Mammals: Associations 3 and 9.
Red squirrels and red-backed voles are the most abundant small mammals. Species diversity increases where this Ecosite is burned.

Breeding Birds: Communities 5 and 21.
A high density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Three-toed Woodpecker, Mountain Chickadee, Swainson's Thrush, and Yellow-rumped Warbler.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The BV2 Ecosite concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and applied to similar landscape (0.2%) in KNP. BV is the Lower Subalpine counterpart of the Montane Athabasca (AT) Ecosection. There are no other mappable Lower Subalpine landscapes that resemble BV2.

Level topography and valley floor positions are conducive to many uses. Gravelly coarse textures provide extensive aggregate supplies but are poor for sewage disposal due to poor ion filtration. Revegetation may be slow because of droughty conditions. BV is of moderate importance to wildlife generally but more important where burned.

Table 84. Wildlife features of BV Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
BV2	medium	elk	low		low	red squirrel	high
BV2B	high	elk moose	low		low		n/a

BY - BRYANT ECOSECTION

The Bryant (BY) Ecosection concept incorporates: Lower Subalpine forest vegetation; glacial landforms consisting of calcareous till, mainly Till C (calcareous, medium textured), or Ice Contact Stratified Drift B (calcareous, variably textured); and well to moderately well drained Eutric Brunisols. Vegetation includes closed forests of Engelmann spruce-subalpine fir, western red cedar and lodgepole pine. Six BY Ecosites (Table 85) differ in vegetation pattern, glacial genetic material and subdominant soils. Fig. 14 illustrates some topographic relationships.

Fig. 14. Landscape schematic of topographic relationships among BY, PL and other Ecosites.

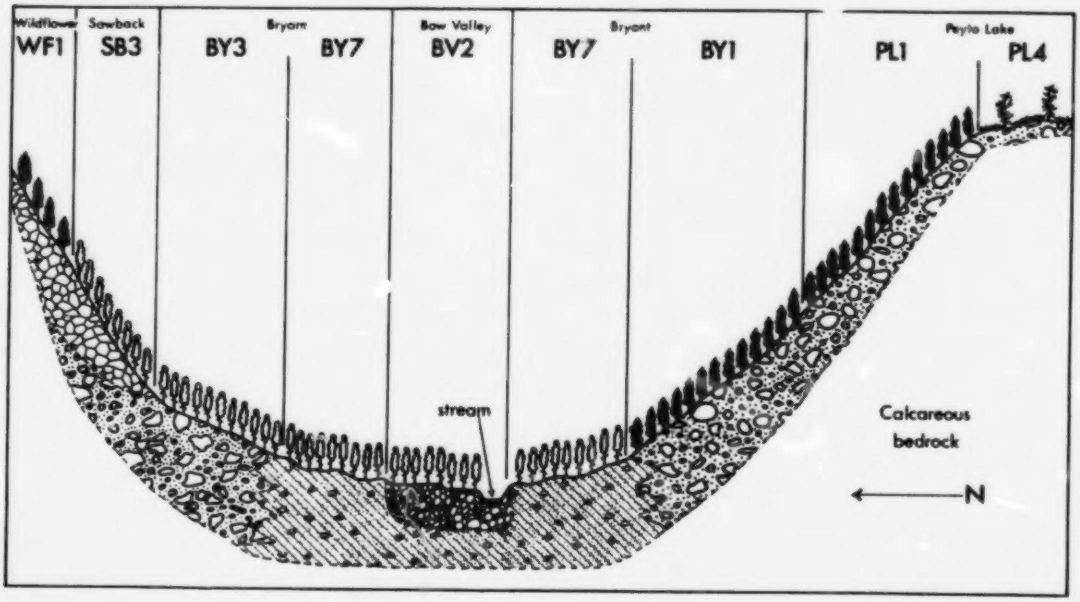

Wildflower
WF1
Sawback
SB3
Bryant
BY3
BY7
Bow Valley
BV2
BY7
Bryant
BY1
PL1
Peyto Lake
PL4
stream
Calcareous bedrock
N

Table 85. Definitive features of Bryant (BY) Ecosites.

Eco-site	Landform	Soils	Vegetation
BY1	Till C; blanket over inclined bedrock	Orthic & Eluviated Eutric Brunisols > Orthic Humo-Ferric Podzol	Engelmann spruce-subalpine fir forest (C14)
BY3	Tills C & D; veneer & blanket over inclined bedrock	Orthic Eutric Brunisol > Eluviated Eutric Brunisol	lodgepole pine forest (C10, C20)
BY4	Ice Contact Stratified Drift B; hummocky & ridged	Orthic & Eluviated Eutric Brunisols	Engelmann spruce-subalpine fir forest (C14)
BY5	Till C > B; blanket over inclined bedrock	Eluviated Eutric Brunisol > Orthic Eutric Brunisol, Orthic Humo-Ferric Podzol	western red cedar forest (C42)
BY6	Tills C & D > B; veneer & blanket over inclined bedrock	Eluviated Eutric Brunisol > Eluviated Dystric Brunisol	Engelmann spruce-subalpine fir forest (C14)
BY7	Ice Contact Stratified Drift B; hummocky & ridged	Orthic & Eluviated Eutric Brunisols	lodgepole pine forest (C20 > C10)

GEOMORPHOLOGY

BY1 and BY5 occur only in the Main Ranges and are characterized by morainal blankets overlying inclined bedrock. Till C (calcareous, medium textured), derived from limestone, is the main constituent of these moraines. All BY5 tracts and some BY1 tracts are associated with Chancellor Formation bedrock and therefore contain mixtures of Till C and Till B (non- to weakly calcareous, medium textured). Till B is the subdominant landform constituent of BY5. Long straight slopes that reflect the underlying inclined bedrock on valley walls are characteristic of landform surface expression in BY1 and BY5. These occasionally grade to hummocky and ridged topography that often reflects bedrock surfaces along valley floors and in cirque basins. The irregular, hummocky to ridged, surface form of two BY1F tracts near Kaufmann Lake and one in Verdant Creek valley is probably due to bedrock failure and to localized karst features. Overall, slopes are 30 to 70% except for a few tracts in the 15 to 30% range. Many slopes, especially long slopes of BY1, are dissected by gullies oriented perpendicular to the contour.

BY3 occurs throughout KNP. In the Main Ranges the morainal landforms are dominated by Till C. Across the Kootenay River valley and into the Western Ranges Till D (calcareous, fine textured) becomes increasingly more abundant in mixtures of Tills C and D. Till B occurs in minor amounts in both areas and is most often found in BY3 tracts locally associated with noncalcareous slaty bedrock. The tills generally occur as veneers or blankets forming long staight slopes that reflect the underlying inclined bedrock on valley walls. These occasionally grade to hummocky and ridged topography that may reflect bedrock control along valley floors. Where the underlying bedrock is recessive, the upper part (usually <50 cm) may be weathered. This residual material can have widely ranging chemical and textural characteristics and is most abundant in BY3 tracts of western KNP. BY3 slopes range from 30 to 70% and the longer ones are often dissected by gullies.

BY6 occurs only in the geologically complex Western Ranges on various till mixtures. Tills C and D are codominant, Till B is subdominant, and intergrades among the three also occur. Minor amounts of Till A (noncalcareous, coarse textured) are also present in some BY6 tracts. The tills occur as veneers and blankets and surface expression usually reflects underlying bedrock. They are inclined on valley walls and have hummocky topography on valley and pass floors. Thin layers of residuum (Residuum A), sandwiched between the till and underlying bedrock, occur where the bedrock is recessive. BY6 slopes are commonly 30 to 70% and often dissected by gullies.

BY4 and BY7 occur in the Main Ranges on valley floor to lower slope positions. The moraine-like glacial landforms consist primarily of Ice Contact Stratified Drift B (calcareous, variably textured) which is a random mixture of morainal, glaciofluvial and glaciolacustrine sediments that are inseparable at the 1:50,000 scale. The glaciolacustrine constituent is most extensive in BY4 and BY7 tracts along the Vermilion River from Marble Canyon to south of the Numa Creek confluence. It occurs there as veneers or blankets overlying other glacial materials and is calcareous and fine textured (*cf.* glaciolacustrine material, Walker *et al.* 1982a). Unvegetated erosional scars, produced by mass movement on unusually steep slopes of glaciolacustrine sediment, occur along Ochre and Numa creeks (Plate 2). Surface expression on the ice contact stratified drift landforms ranges from hummocky and ridged on valley floors to inclined on lower valley walls. These forms usually reflect deposition rather than bedrock control. BY4 and BY7 slopes are complex and 5 to 45%, although localities with gentler and steeper slopes also exist. Gullying and channelling are the most important modifying processes and both influence landform expression. Small glaciofluvial terraces may also be present and add to slope complexity.

Eolian material B (altered, medium textured) sporadically mantles all BY landforms but is most important and extensive in BY1, BY5 and BY6. It can occur as a thin, discontinuous veneer with an abrupt lower boundary or, more often, as an eolian-glacial material mixture generated by processes such as solifluction, soil creep, and tree throw. Such mixtures are particularly abundant in BY6 where turbic phase soils are common.

SOILS

Soils characteristic of the BY Ecosection are well to moderately well drained Eutric Brunisols. Definitive soil subgroup patterns of each BY Ecosite are in Table 85. Although there are taxonomic differences, the soils are closely related. Ae horizon development and thickness vary across the landscape and seems to be related to slope gradient, parent material calcareousness, presence of Eolian material B, and the age and degree of surficial disturbance and erosion. Soils with thin Ae horizons are classed as Orthic and those with thicker Ae horizons are classed as Eluviated Eutric Brunisols. Orthic Humo-Ferric Podzols, subdominant soils in BY1 and BY5 and accessory soils in BY4 and BY7, are associated with strong weathering on comparatively old, stable sites in Till B and low lime intergrades or where appreciable amounts of Eolian material B is present in upper horizons. The Eutric Brunisols can have nonpodzolic Bf horizons. Orthic Humo-Ferric Podzols occur rarely in BY6 because the B horizons that have high extractable iron and aluminum also have high clay content (Table D5). The iron + aluminum to clay ratio excludes them from Bf or podzolic Bf (C.S.S.C. 1978b). Dystric Brunisols, the subdominant soils of BY6 and accessory soils of BY3, BY5, and BY6, are associated with Till B and low lime intergrades. A pedon classed as Eluviated Eutric Brunisol (Table D5, Plate 11), illustrating BY soils, is from a BY6 tract in Luxor Pass. The lower horizons are slightly coarser textured and more stratified than typical of BY soils developed in till. Incorporation of material from quartzitic bedrock plus the topographic position near the pass floor account for the coarseness and stratification in the till.

Many other profiles in the vicinity of the sampled pedon exhibited disrupted and mixed upper horizons. Such turbic features occur in many BY soils and are most common in BY3 and BY6. Other accessory soils are Orthic and Brunisolic Gray Luvisols associated with glaciolacustrine material on BY4 and BY7. These are the only occurrences of Luvisolic soils above the Montane Ecoregion. BY3 has some Eutric Brunisols with luvisolic tendencies but has few or no Luvisolic soils.

VEGETATION

BY1, BY4 and BY6 are characterized by Engelmann spruce-subalpine fir forest with Engelmann spruce-subalpine fir/false azalea (C14) as the dominant v.t. Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) and Engelmann spruce-subalpine fir/green alder (C25) are accessory v.t.s. C21 occurs at high elevations transitional to Upper Subalpine and is important in BY1 and BY6. C25 occurs at low elevations transitional to Montane and is important in BY4 and BY6.

BY3 and BY7 are characterized by lodgepole pine forest, with lodgepole pine/green alder/feathermoss (C10) and lodgepole pine/false azalea/grouseberry (C20) predominant. BY7 usually has a v.t. pattern in which C20 is more abundant than C10. Lodgepole pine/buffaloberry/twinflower (C19) is an accessory v.t. associated with Luvisolic soils and glaciolacustrine material on BY7. Lodgepole pine v.t.s of limited distribution include lodgepole pine/juniper/bearberry (C3), lodgepole pine/buffaloberry/showy aster (C6) and lodgepole pine/buffaloberry/grouseberry (C18) on BY3 and lodgepole pine/buffaloberry/bunchberry (C39) on BY3 and BY7.

Early successional, post-fire vegetation dominates the few tracts of BY3B and BY7B. Stands on such landscapes in the Vermilion Pass area are of the lodgepole pine/twinflower-fireweed (S5) v.t. BY1A, BY3A, BY4A, and BY6A landscapes have 20 to 50% of the area modified by snow avalanching. Modification is mainly to vegetation and avalanche v.t.s such as subalpine fir-willow (S2) occur.

BY5 is unique in the Rocky Mountain national parks because it is dominated by the western red cedar/oval leaf blueberry (C42) v.t. which resembles low elevation vegetation of the moister Columbia Mountains to the west. BY5 is restricted to moist, near-Montane, low elevation areas in Vérendrye and Serac creek valleys. C14 is an accessory v.t. which occurs as small patches interspersed with the C42 stands.

WILDLIFE

BY1 Wildlife Features

Ungulates: BY1 is generally of low importance, although all species except bighorn sheep and mountain goat were recorded here. Use of BY1 by elk and moose in summer is much higher where it is avalanched (*e.g.* Assiniboine Slides).

Carnivores: Overall, BY1 is of low importance to carnivores, except to martens which occur at high densities.

Small Mammals: Associations 2 and 3.
A moderate number of species occurs here. Red-backed voles and porcupines occur at high densities.

Breeding Birds: Community 8.
A high density of birds was recorded. Species diversity is high. Based on density indices derived from circular census plots, this Ecosite is highly important to Rufous Hummingbird, Wilson's Warbler, and Golden-crowned Kinglet.

BY3 Wildlife Features

Ungulates: BY3 is of low importance to ungulates overall, but of moderate importance to elk in summer. BY3 in the Vermilion Pass burn, because of early successional vegetation (S5), is very highly important to elk, moose, and mule deer in summer and fall. High snow accumulation precludes use in winter by all but a few moose. Browse use was low and moderate in C10 and C20 v.t.s, respectively, but high in S5. Heavy use was recorded on willow

Table 86. Wildlife features of BY Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
BY1	low		low		medium	porcupine red-b. vole	high
BY3	low	elk	medium	weasel wolverine	medium	red squirrel red-b. vole	low
BY3B	high	elk moose deer	high	coyote wolverine	low		n/a
BY4	medium	moose	high	marten weasel	low	red-b. vole	high
BY5	low	moose	low		low	red-b. vole deer mouse	medium
BY6	medium	moose	low		low	red-b. vole deer mouse	low
BY7	medium	elk	high	coyote cougar lynx	medium	hare red-b. vole deer mouse	medium
BY7B	high	elk deer	high	coyote cougar	low		n/a

(*Salix glauca*), poplar (*Populus tremuloides*, *Populus trichocarpa*), and false azalea (*Menziesia glabella*).

Carnivores: BY3 is moderately important to most carnivores and highly important to weasels and wolverines. This Ecosite is more important to large carnivores in the Vermilion Pass burn because of high summer use by ungulates.

Small Mammals: Associations 3 and 9.

A moderate number of species occurs here with red squirrels and red-backed voles occurring at high densities. In the Vermilion Pass burn, species diversity is increased although relative abundance is low.

Breeding Birds: Communities 5, 19 and 21.

A low density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Swainson's Thrush, Mountain Bluebird, and Downy Woodpecker.

BY4 Wildlife Features

Ungulates: Importance of BY4 to ungulates overall is moderate in summer and high for moose in winter. High snow accumulation precludes winter use by all but moose. Use is highest, at all seasons, where BY4 is associated with fluvial Ecosites (AT2, HC1, PP3) and the Highway 93 right-of-way.

Carnivores: BY4 is moderately important to most carnivores and highly important to martens and weasels.

Small Mammals: Associations 2 and 3.

A low number of species occurs here and only red-backed voles occur at high densities.

Breeding Birds: Community 8.

A high density of birds was recorded. Species diversity is high. Based on density indices derived from circular census plots, this Ecosite is highly important to Townsend's Warbler, Golden-crowned Kinglet, Gray Jay, and Boreal Chickadee.

BY5 Wildlife Features

Ungulates: BY5 is limited to the Vérendrye and Serac creek area and is generally of low importance to ungulates, except moose. Moose winter along both creeks, but are confined to the creek beds and adjacent banks due to deep snow.

Carnivores: Overall, BY5 is of low importance, although it is moderately important to coyotes, martens and lynx.

Small Mammals: Association 2.
A moderate number of microtines occurs here with red-backed voles and deer mice having the highest densities.

Breeding Birds: Communities 5 and 8.
A medium density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Winter Wren and Golden-crowned Kinglet.

BY6 Wildlife Features

Ungulates: BY6 is moderately important overall in summer and of high importance to moose in winter. The majority of BY6 tracts occur on east aspects of the Brisco Range where winter snow accumulation is moderate compared to BY tracts in the Vermilion watershed.

Carnivores: A general lack of prey species makes BY6 of low importance.

Small Mammals: Associations 2 and 3.
BY6 has a low species diversity and only red-backed voles occur at high densities.

Breeding Birds: Community 8.
A low density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Ruby-crowned Kinglet and Boreal Chickadee.

BY7 Wildlife Features

Ungulates: BY7 is generally confined to lower elevations of the Vermilion Valley where it is of moderate importance overall to ungulates, but of high importance to elk in late spring and early summer. Use by elk and moose is highest where BY7 is associated with HC1 and PP3, and Highway 93. Recently burned BY7 tracts near Vermilion Pass with S5 vegetation are very highly important to elk and mule deer in summer.

Carnivores: BY7 is highly important to coyotes and cougars in summer and to lynx year round. It is moderately important to mustelids. It is similarly of high importance to large carnivores in the Vermilion Pass burn, because of the very high use by elk and deer in summer.

Small Mammals: Associations 2, 3 and 9.
A moderate number of species was found here. Snowshoe hares, red-backed voles and deer mice occur at high densities. Species diversity is higher in the S5 v.t. of the Vermilion Pass burn, however relative abundance is low.

Breeding Birds: Communities 5, 19 and 21.
A medium density of birds was recorded. Species diversity is high. Based on density indices derived from circular census plots, this Ecosite is highly important to Golden-crowned Kinglet and Pine Siskin.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The BY Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and modified slightly to better accommodate similar landscape (8.2%) in KNP. BY1 (2.0%) and BY4 (0.8%), with slightly modified concepts, were also carried over from BNP and JNP to KNP. BY3 (2.5%) and BY7 (1.8%) concepts were added to accommodate calcareous glacial terrain dominated by lodgepole pine in the Lower Subalpine of KNP. These closely resemble the Panorama Ridge 1 (PR1) and 6 (PR6) concepts in BNP and JNP, except that BY3 and BY7 have few or no Luvisolic soils. BY5 (0.4%) and BY6 (0.7%) were added to accommodate, respectively, western red cedar forest and lithologically complex morainal landforms in the Western Ranges. Neither of these landscape features were found in BNP and JNP. KNP does not have landscapes like those of BY2 in BNP and JNP.

BY is the Lower Subalpine counterpart of the Upper Subalpine Peyto Lake (PL) Ecosection. Cavell (CA) resembles BY but occurs on non- to weakly calcareous glacial materials and is dominated by Dystric Brunisols.

Use is limited by steep slopes or irregular topography. Locally, use may be affected by gullies, shallow soils, fine textured and gravelly coarse textured ice contact stratified drift deposits. Removal of vegetation may result in erosion on steep slopes. BY5 with western red cedar/oval leaf blueberry (C42) forests is unique in the Rocky Mountain parks.

BY is moderately important to wildlife overall but, where adjacent to fluvial landforms, is important to birds and ungulates. Burned tracts are also important to ungulates.

CA - CAVELL ECOSECTION

The Cavell (CA) Ecosection concept incorporates: Lower Subalpine forest vegetation; glacial landforms comprised of non- to weakly calcareous, medium textured till (Till B) or non- to weakly calcareous, variably textured ice contact stratified drift (Ice Contact Stratified Drift C); and well to moderately well drained, acidic soils, mainly Dystric Brunisols. Vegetation includes closed forests of Engelmann spruce-subalpine fir and lodgepole pine. Three CA Ecosites (Table 87) differ in vegetation patterns and a dry > wet landscape pattern, although concomitant soil and landform differences also occur. CA Ecosites occur in the Main Ranges east of the Vermilion-Mitchell ranges, most often on valley walls and floors, occasionally in cirques and cols and on ridge tops. Fig. 15 shows topographic relationships.

GEOMORPHOLOGY

CA is geomorphically characterized by glacial landforms comprised of Till B (non- to weakly calcareous, medium textured) or Ice Contact Stratified Drift C (non- to weakly calcareous, variably textured). Although CA2 is characterized by Till B (Table 87), several tracts along or near valley floors contain appreciable amounts of the ice contact material, *e.g.* CA2 tracts at the mouth of Tumbling Creek valley and in the Ottertail River valley. Most CA tracts are in the western Main Ranges where glacial materials are derived from Chancellor Formation slate. Till C (calcareous, medium textured) and Ice Contact Stratified Drift B (calcareous, variably textured) also occur in minor amounts, particularly along some valley floors and in CA tracts near the boundary between the western and eastern Main Ranges. A few tracts occur in the eastern Main Ranges (above Vermilion Pass and in East Verdant Creek valley) where glacial materials are derived from Miette Group slate. The CA4B tract at Vermilion Pass also contains some Till A (noncalcareous, coarse textured) derived locally from quartzitic bedrock. Whether Chancellor Formation or Miette Group, the slaty bedrock is recessive and the mountain topography is subdued. The top part of this recessive bedrock is occasionally weathered, particularly where the overburden is shallow. This weathered bedrock is Residuum A (non- to weakly calcareous, medium textured) and occurs as a veneer sandwiched between Till B above and consolidated bedrock below.

Eolian material B (altered, medium textured) is a common constituent of CA landforms. It occurs as a thin, discontinuous veneer at the surface or, more often, as a mixture of eolian and glacial deposits generated by solifluction, soil creep and tree throw. Wet depressional segments (about 30%) of the dry > wet landscape pattern characterizing CA1 often have a parent material sequence of organic material over silty veneer over glacial materials. The silty veneer may be of eolian, fluvial, or fluviolacustrine (slope wash) origin and is currently noncalcareous, has few coarse fragments and may be stratified with organic material. The organic layers mantling the mineral deposits are primarily

Fig. 15. Landscape schematic of topographic relationships among CA and other Ecosites.

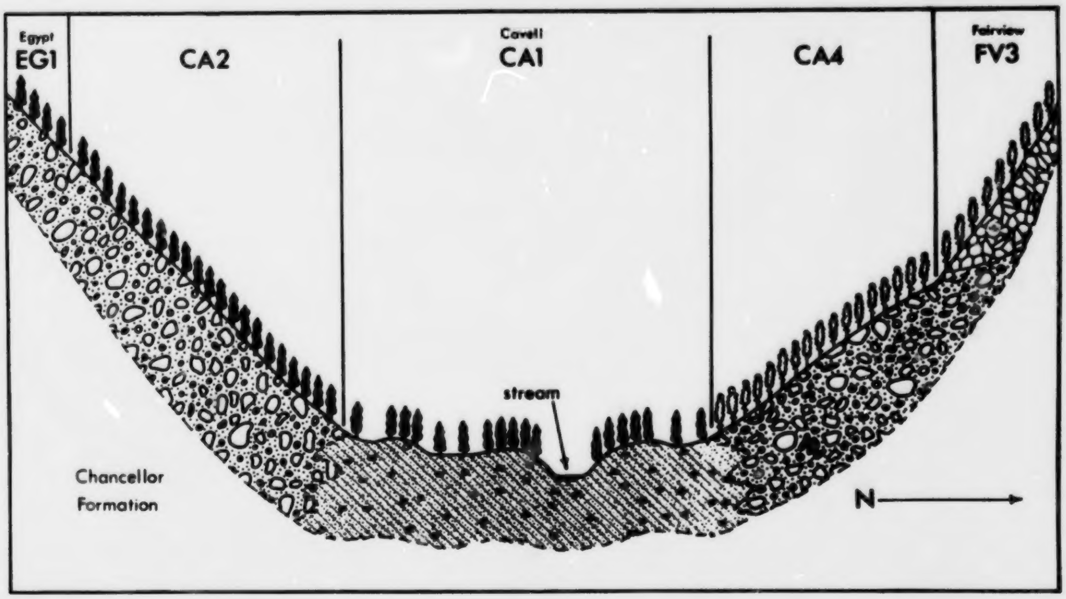


Table 87. Definitive features of Cavell (CA) Ecosites.

Eco-site	Landform	Soils	Vegetation
CA1	Ice Contact Stratified Drift C; hummocky & ridged	Dry^{70}: Eluviated Dystric Brunisol > Orthic Dystric Brunisol, Orthic Humo-Ferric Podzol Wet^{30}: Orthic Gleysol, Gleyed Ferro-Humic Podzol, Terric Mesisol	Engelmann spruce-subalpine fir forest (C14) wet spruce open forest (O11), wet Engelmann spruce-subalpine fir open forest (O14)
CA2	Till B; veneer & blanket over inclined bedrock	Eluviated Dystric Brunisol > Orthic Dystric Brunisol, Orthic Humo-Ferric Podzol	Engelmann spruce-subalpine fir forest (C14)
CA4	Till B; veneer & blanket over inclined bedrock	Eluviated Dystric Brunisol > Orthic Dystric Brunisol	lodgepole pine forest (C20)

moderately decomposed fen peat, even though fen vegetation has often been succeeded by open forest. Where the peat is >40 cm thick, the landform is horizontal fen (C.S.S.C. 1978b).

The morainal material commonly occurs as a veneer or blanket and the surface expression (Table 87) reflects the underlying bedrock. Most morainal slopes are long and straight, reflect inclined bedrock, range from 30 to 70% and occur on valley walls. Occasionally, hummocky and ridged morainal topography also occurs. Tracts with the modifier X (*e.g.* two tracts on a ridge top east of Wardle Creek) are dominated by morainal veneer and lithic phase soils. Partial failure of the bedrock in a CA4F tract below Mount Haffner has produced ridged to hummocky, bench-like topography superimposed on an inclined slope. Ice contact stratified drift forms moraine-like landforms along valley floors. Surface form is usually of depositional origin, although shallower deposits (blankets) overlying bedrock occur occasionally. Hummocky and ridged surfaces, with complex slopes ranging from 15 to 45%, are typical. Small terraces and slopes <15%, particularly on wetland segments, are included in both CA1 tracts.

SOILS

The well to moderately well drained, moderately to well developed soils that characterize CA reflect the acidic to neutral, medium textured, parent material; the presence of Eolian material B; and the cool, moist Lower Subalpine environment. The soil taxa (Table 87), although seemingly different, have characteristics grouped around taxonomic boundaries. B horizon development is moderate to strong and ranges from Bm and Bf (Brunisolic soils) to podzolic Bf (Podzolic soils). Bf and podzolic Bf develop more often where Eolian material B is a significant constituent of upper sola. A horizon development also varies across the landscape and is a function of surficial material, slope gradient, and stability relative to disturbance processes such as solifluction, soil creep, and tree throw. Most often, thin Ae horizons are present, while less frequently, A horizons are absent or mixed with B horizon material (AB horizon). Dystric Brunisols are divided into Eluviated (>2 cm Ae) or Orthic (little or no Ae) subgroups on the basis of eluvial (Ae) horizon development and thickness. A pedon (Table D6, Plate 12), from a CA2 tract below Vermilion Peak, has textural characteristics typical of both ice contact stratified drift (lower horizons are stratified) and till (C2 horizon). The upper solum horizons have been mildly disturbed but such turbic phases occur often in CA2 and CA4, particularly on steep slopes. Lithic phases, associated with morainal veneers, occur occasionally in CA2 and CA4 and dominate two tracts mapped with the modifier X.

Wetland accounts for approximately 30% of CA1 and normally occurs in inter-ridge and hummock depressions. Seepage, high water tables, and surface water collection account for the poorly to very poorly drained soils. The soil pattern is complex and best represented by Orthic Gleysols, Gleyed Ferro-Humic Podzols, and Terric Mesisols with minor amounts of Gleyed Dystric Brunisols on slightly elevated, imperfectly drained sites and wetland margins. Gleying is variable in the poorly drained mineral soils but B horizon development indicates that upper sola are periodically oxidized. B horizons range from Bg, Bm, Bf, Bhf and Bh (Gleysolics) to podzolic Bf, Bhf and Bh (Podzolics). The iron, aluminum, and humus enriched B horizons usually develop in the silty veneer overlying glacial material. Gleyed Ferro-Humic Podzols best represent a range of Podzolic great groups that also includes Humo-Ferric and Humic Podzols. Favorable moisture, nutrient and vegetation conditions resulted in the accumulation of fen peat on most CA1 wetland soils. Terric Mesisols and other Organic soils occur where the peat is >40 cm thick. Such localities are usually very poorly drained with prolonged saturation and occasional ponding.

VEGETATION

CA2 and the dry upland segment of CA1 are characterized by Engelmann spruce-subalpine fir forest with Engelmann spruce-subalpine fir/false azalea (C14) the predominant v.t. Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) and Engelmann spruce-subalpine fir/green alder (C25) are accessory v.t.s. C21 occurs at higher elevations transitional to Upper Subalpine and C25 at low elevations transitional to Montane. Tracts with the modifier A (*e.g.* CA2A) have 20 to 50% of the area modified by snow avalanching. Modification is mainly to vegetation and avalanche v.t.s such as subalpine fir-willow (S2) and green alder/fern (S13) occur on avalanche paths.

CA4 is characterized by lodgepole pine forest with lodgepole pine/false azalea/grouseberry (C20) the predominant v.t. The lodgepole pine/green alder/feathermoss (C10) v.t. also occurs and often is of limited extent. Early successional, post-fire vegetation dominates the CA4B tract near Vermilion Pass. Stands in this tract were classed as lodgepole pine/twinflower-fireweed (S5) and early C20.

Wetland segments of CA1 are characterized by wet spruce and spruce-fir open forest, mainly the spruce/Labrador tea/brown moss (O11) and Engelmann spruce-subalpine fir/rock willow/bracted lousewort (O14) v.t.s. Small patches of wet shrubby vegetation, mainly dwarf birch-shrubby cinquefoil-willow/brown moss (S1), also occur.

WILDLIFE

CA1 Wildlife Features

Ungulates: The two tracts of CA1 in KNP occur along upper Numa Creek and East Verdant Creek. CA1 is moderately important to elk in summer and fall, and highly important to moose year round. Moose wintered on East Verdant Creek in both 1981-82 and 1982-83 where January snow depths averaged 70 and 80 cm, respectively. Browse use along East Verdant Creek is very high especially on false azalea (***Menziesia glabella***), willow (***Salix glauca***) and tall bilberry (***Vaccinium membranaceum***).

Carnivores: CA1 is moderately important to a large number of species and because of this diversity is of high importance. Only weasels occur at high densities.

Small Mammals: Associations 2 and 4.
A moderate number of species occurs here at low densities.

Breeding Birds: Community 8.
A high density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Boreal Chickadee, Varied Thrush, Swainson's Thrush, Yellow-rumped Warbler and Townsend's Warbler.

CA2 Wildlife Features

Ungulates: CA2 is very highly important to elk in summer and fall, particularly in the Vermilion Peak and Marble Canyon areas, and highly important to moose, especially in winter. Browse use is high with heavy browsing on false azalea (***Menziesia glabella***), green alder (***Alnus crispa***) and rhododendron (***Rhododendron albiflorum***).

Carnivores: High prey availability, especially in summer, makes CA2 very highly important. High densities of coyotes, martens, weasels, cougars and lynx occur here.

Small Mammals: Associations 2 and 3.
A moderate number of species occurs here. Snowshoe hares and red-backed voles occur at high densities.

Breeding Birds: Community 8.
A medium density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Swainson's Thrush and Golden-crowned Kinglet.

CA4 Wildlife Features

Ungulates: This uncommon Ecosite is of low importance to ungulates, except in the Vermilion Pass burn where, with S5 vegetation, it is of moderate to high importance to elk in summer and moose in winter.

Carnivores: CA4 is of high importance to lynx and of moderate importance to other carnivores.

Small Mammals: Associations 3 and 9.
A low number of species occurs on CA4. Only snowshoe hares occur at high densities. CA4 tracts in the Vermilion Pass burn with S5 v.t. have a high number of species at low densities.

Breeding Birds: Communities 5, 19 and 21.
A low density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Townsend's Warbler.

Table 88. Wildlife features of CA Ecosites.

Ecosite	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
CA1	high	moose	high	weasel	low		high
CA2	high	elk moose	very high	coyote lynx marten weasel	medium	hare red-b. vole	medium
CA4	low		medium	cougar lynx	low	hare	low

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The CA Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and modified slightly to better accommodate similar landscapes (2.3%) in KNP. In KNP, CA1 (0.4%) landforms are dominantly ice contact material instead of morainal material as in BNP and JNP, even though several tracts in BNP and JNP were described as containing appreciable amounts of Ice Contact Stratified Drift C, at that time called a variant of Ice Contact Stratified Drift A (noncalcareous, coarse textured). CA2 (1.7%) and CA4 (0.2%) were extended, with minor modifications, to KNP.

CA is the Lower Subalpine counterpart of the Upper Subalpine Egypt (EG) and Alpine Jonas (JN) Ecosections. Bryant (BY) resembles CA but occurs on calcareous glacial materials and is dominated by Eutric Brunisols. The compound CA1 concept, with two distinctive but cartographically inseparable landscape segments, becomes inappropriate at mapping scales larger than 1:50,000. The drier, upland segments become mappable as CA2 and the wetland segments become mappable as an entirely wet, undefined, Consolation Valley (CV) Ecosite similar to CV1.

Use is limited where slopes are steep or topography is irregular. Locally, use may be affected by seepage, wet depressions, and gravelly coarse textured ice contact deposits. Removal of vegetation may result in erosion on steep slopes.

CA is highly important to elk in summer, moose year round, and a variety of carnivores. Bird densities are high in some sites. Burned tracts are important to ungulates.

CV - CONSOLATION VALLEY ECOSECTION

The Consolation Valley (CV) Ecosection concept incorporates a complex of *wetland* and *dry* upland soils and vegetation occurring on glacial landforms in the Lower Subalpine. Various glacial genetic material units may occur but the prevalent feature is wetness due to seepage and high water tables associated with ground water discharge. Major areas of groundwater discharge occur on the floors and lower slopes of valleys and low passes in the Main Ranges which are physiographic positions characteristic of CV. Only CV1 (Table 89) was recognized and it is typified by a wet > dry landscape pattern. Wetlands (poorly to very poorly drained) dominate, accounting for about 80% of the compound concept. Dry uplands (well to moderately well drained) occupy about 20% of the landscape, occurring in slightly elevated localities where the fluctuating water table rarely reaches the control section. Fig. 16 illustrates topographic relationships among CV1 and some other Ecosites.

Fig. 16. Landscape schematic of topographic relationships among CV1 and other Ecosites.

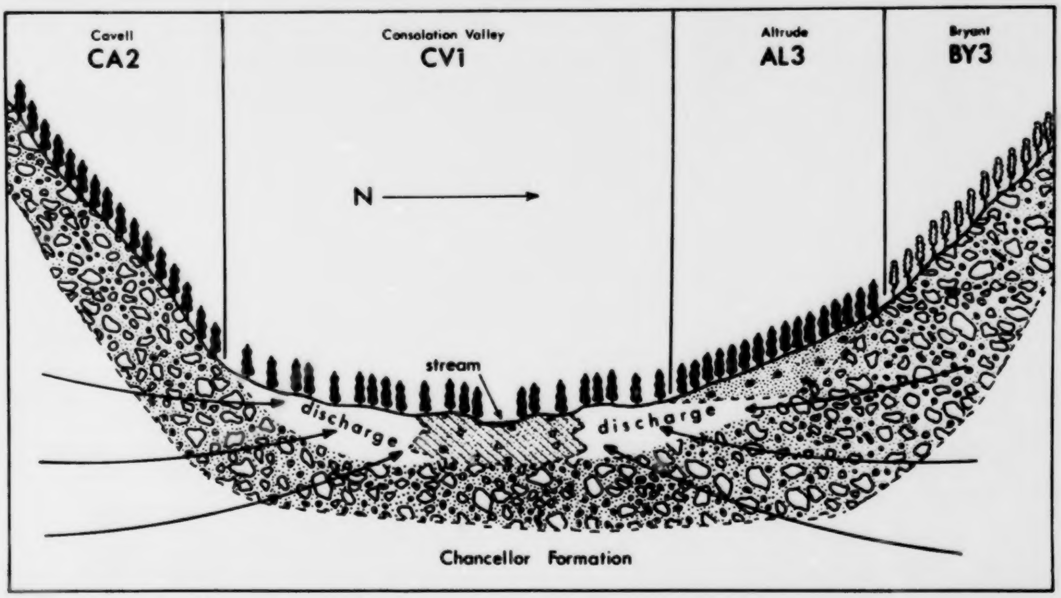


Table 89. Definitive features of Consolation Valley (CV) Ecosites.

Eco-site	Landform	Soils	Vegetation
CV1	Tills B & C; inclined, hummocky & ridged including bedrock control > sloping fen	Wet^{80}: Orthic Gleysol, Gleyed Ferro-Humic Podzol, Terric Mesisol Dry^{20}: Eluviated Eutric Brunisol, Eluviated Dystric Brunisol	wet spruce open forest (O11), wet Engelmann spruce-subalpine fir open forest (O14) Engelmann spruce-subalpine fir forest (C14), lodgepole pine forest (C20)

GEOMORPHOLOGY

CV is characterized by glacial landforms composed of Till B (non- to weakly calcareous, medium textured), Till C (calcareous, medium textured) or mixtures of the two. Ice Contact Stratified Drift B (calcareous, variably textured) is an important if not dominant constituent of at least two CV1 tracts; one near Vermilion Crossing, the other in the valley between Boom Mountain and Mount Whymper. Wetlands are usually thinly mantled by peat. This fen peat, rarely >1.2 m thick, is mainly moderately decomposed but fibric and humic layers and wood fragments also occur. Where the peat is >40 cm thick, the landform is sloping or, less often, horizontal fen, recognizing that fen vegetation has usually been succeeded by open forest. A silty veneer of eolian, fluvial or fluviolacustrine origin may occur between the peat and underlying glacial material. This dominantly mineral veneer is most often fluvial and/or fluviolacustrine, is presently noncalcareous, contains few coarse fragments and may be stratified with organic material. Eolian material B (altered, medium textured) occurs occasionally as a thin, discontinuous veneer forming the mineral surface on dry uplands.

Surface expression is predominantly hummocky and ridged on valley floors but becomes inclined on lower valley walls. Inclined slopes generally reflect the underlying bedrock. Hummocky and ridged topography reflects underlying bedrock, glacial deposition or post-depositional slope failure. Failed till slopes in CV1 tracts are usually seepage induced, rotational slumps and are less common in KNP than in BNP and JNP. Slopes are complex and 5 to 15%, although slopes <5% also occur. Ponds occur infrequently.

SOILS

Wetland dominates CV1 and has a complex pattern of predominantly poorly to very poorly drained soils represented by Orthic Gleysols, Gleyed Ferro-Humic Podzols, and Terric Mesisols. Gleying is variable in the poorly drained mineral soils but B horizons indicate that upper sola are periodically oxidized. B horizons range from Bg, Bm, Bf, Bhf, and Bh (Gleysolics) to podzolic Bf, Bhf and Bh (Podzolics). The iron, aluminum, and humus enriched B horizons usually develop in the silty veneer overlying the glacial materials. Gleyed Ferro-Humic Podzols best represent the range of Podzolic great groups that includes Humo-Ferric and Humic Podzols. A pedon (Table D7, Plate 13), from the CV1 tract along Verdant Creek, illustrates soil features of CV1. The high organic carbon content of the Bh horizon may be partly due to incorporation of organic material during sedimentation of the fluvial veneer.

Favorable moisture, nutrient and vegetational conditions resulted in the accumulation of fen peat on most CV1 wetland soils. Terric Mesisols and other Organic soils occur where the peat is >40 cm thick. Such localities are usually the wettest (very poorly drained), with prolonged saturation and occasionally, ponding. The Orthic Humic Podzol pedon (Table D7) has a peaty surface with Of and Oh horizons, although Om is more common on CV1 soils.

The dry upland segment is subdominant in CV1, occurs on elevated sites such as hummock and ridge crests and has well to moderately well drained soils. The characteristic soils are Eluviated Eutric and Dystric Brunisols. Both have Ae horizons, although soils without Ae horizons (Orthic Eutric and Dystric Brunisols) also occur occasionally. Eutric Brunisols are associated with calcareous glacial materials and Dystric Brunisols with non- to weakly calcareous glacial materials. Orthic Humo-Ferric Podzols may also be present. Other important soils of limited distribution are Gleyed Eutric and Dystric Brunisols occurring in imperfectly drained sites transitional between the wet and dry segments.

VEGETATION

CV1 wetlands are characterized by wet spruce and spruce-fir open forest, mainly the spruce/Labrador tea/brown moss (O11) and Engelmann spruce-subalpine fir/rock willow/bracted lousewort (O14) v.t.s. O11 is more common at low elevations and O14 (Plate 14) at high elevations of the Lower Subalpine. Small patches of wet shrubby meadow, mainly dwarf birch-shrubby cinquefoil-willow/brown moss (S1), also occur. There may also be minor amounts of water sedge-beaked sedge (H11) around the few ponds on some CV1 tracts.

The dry uplands are characterized by spruce-fir forest, mainly Engelmann spruce-subalpine fir/false azalea (C14), or by lodgepole pine forest, mainly lodgepole pine/false azalea/grouseberry (C20). Other v.t.s occurring occasionally are lodgepole pine/green alder/feathermoss (C10) and Engelmann spruce-subalpine fir/green alder (C25), both at low elevations within the Lower Subalpine.

WILDLIFE

CV1 Wildlife Features

Ungulates: There are only a few tracts of CV1 in KNP. It is of moderate importance to ungulates in summer, particularly elk. Snow depths >1.0 m preclude winter use by ungulates except for moose. Browse use is moderate, primarily on willows (*Salix barrattiana, Salix glauca*, and *Salix vestita*) and dwarf birch (*Betula glandulosa*).

Carnivores: CV1 is highly important, especially to martens but also to wolverines and cougars where they occur.

Small Mammals: Associations 2, 3 and 4.
High habitat diversity results in a large number of species. Red-backed voles, meadow voles, deer mice and yellow-pine chipmunks occur at high densities.

Breeding Birds: Communities 5, 6, 8 and 19.
A high density of birds was recorded. Species diversity is high. Based on density indices derived from circular census plots, this Ecosite is highly important to Yellow-rumped Warbler, Varied Thrush, Three-toed Woodpecker, Gray Jay and Brown Creeper.

Table 90. Wildlife features of CV Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
CV1	medium	elk	high	marten wolverine cougar	medium	red-b. vole meadow vole dusky shrew	high

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The CV and CV1 concepts were developed during the BNP and JNP inventory (Walker *et al.* 1982d) and applied with few changes to virtually identical landscapes (0.5%) in KNP. CV is the Lower Subalpine counterpart of the Upper Subalpine Sphinx (SX) Ecosection, which is drier than CV and is affected by seasonal seepage. Hector 1 (HE) is wet and has vegetation similar to CV1 but occurs on fluvial landforms where recent sedimentation has affected soil development. The compound CV1 concept, with two distinctive but cartographically inseparable landscape segments, becomes inappropriate at mapping scales larger than 1:50,000. The subdominant, dry uplands become mappable as Cavell 2 (CA2) or Cavell 4 (CA4) where the glacial materials are non- to weakly calcareous or as one of the Bryant (BY) Ecosites where the glacial materials are calcareous. The wetlands become mappable as an undefined, entirely wet, CV Ecosite

Poor to very poor drainage due to ground water discharge severely limits most uses. CV may play a role in regulating streamflow. Major construction may change hydrologic patterns.

CV is very important to small mammals, martens and wolverines. Numerous birds species occur in high densities.

DG - DRY GULCH ECOSECTION

The DG Ecosection concept incorporates: landforms composed of calcareous colluvium, well drained Brunisolic and Regosolic soils and Montane vegetation including both open and closed coniferous forests. Three DG Ecosites (Table 91) are recognized.

DG occupies lower to middle elevations on steep slopes south of Vermilion Crossing. Its distribution is restricted to the western Main Ranges and the Western Ranges. DG usually is closely associated with calcareous bedrock. The lower valley wall position makes it likely that DG landscapes have developed in post-glacial time. Fig. 17 illustrates topographic relationships among DG and other Ecosites.

Table 91. Definitive features of Dry Gulch (DG) Ecosites.

Ecosite	Landform	Soils	Vegetation
DG1	Colluvium C & D; blanket & veneer over inclined bedrock, apron	Orthic Eutric Brunisol > Orthic Regosol	Northerly: white spruce-Douglas fir forest (C5) Southerly: Douglas fir forest (C1)
DG3	Colluvium C & D; veneer over inclined bedrock + exposed bedrock	Lithic phases: Orthic Regosol > Orthic Eutric Brunisol, Orthic Humic Regosol; + nonsoil	Douglas fir open forest (O5)
DG6	Colluvium C & D; blanket & veneer over inclined bedrock	Orthic Eutric Brunisol > Orthic Regosol	lodgepole pine forest (C19, C39)

GEOMORPHOLOGY

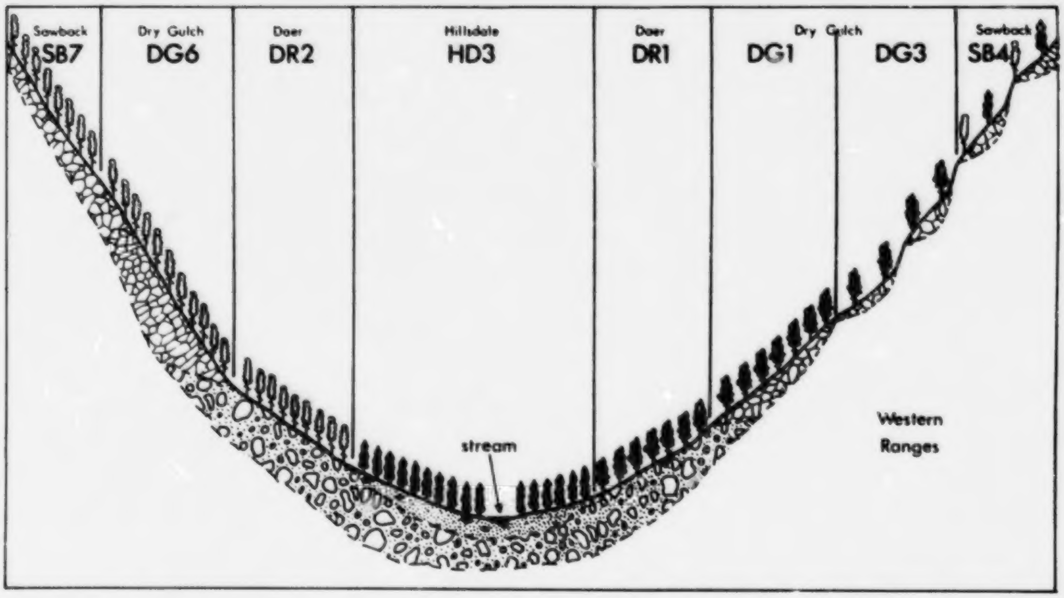
Colluvium C (calcareous, medium textured) occurs consistently throughout the range of DG (Table 91), and is its predominant material in the western Main Ranges. Colluvium C is codominant with Colluvium D (calcareous, fine textured) in the Western Ranges. The colluvium, especially Colluvium D, occasionally overlies a veneer of weathered bedrock if the bedrock is inherently soft. The veneer is usually Residuum C, with Residuum A and Residuum B occurring less frequently. The residuum has most often developed in McKay Group shales.

The colluvium frequently occurs as uniform blankets or veneers, the thinner of which only subtly mask the underlying bedrock surface. However, in DG3 the colluvium is normally discontinuous over bedrock and bedrock outcrops make up much of the landscape.

Long, straight inclines are typical for DG1 and DG6 landscapes. Slopes may be 45 to 100%, but are usually 55 to 70%. DG3, with a cliff and bench topography, has less uniform slopes that frequently average >70%.

In general, the steeper the slope, the broader the area that adjusts to restabilize the slope after minor disturbances such as the uprooting of trees. Steep southerly aspects are often dry and may have

Fig. 17. Landscape schematic of topographic relationships among DG, DR and other Ecosites.



mineral soil exposed to erosion. The tendency towards surface instability in colluvium is heightened by its loose packing. Thus, intact eolian veneers are rare in DG.

Snow avalanching normally occurs on <20% of any DG tract. Where 20 to 50% is avalanched, the modifier A accompanies the Ecosite symbol. Avalanching is most common on DG3. The few DG tracts that are >50% avalanched are included within DG3A. The extent to which avalanching modifies the mineral surface depends on the amount of debris deposited. Infrequently avalanched areas are usually the only ones disrupted by the uprooting of vegetation.

Avalanched areas are often prone to other surface distrubances, especially on DG3. For instance, colluvium below cliffs can be quite rubbly through talus buildup. Couloirs that channel snow avalanches also channel meltwater and mudflows. Cones formed below couloirs are thus usually heterogeneous in makeup. Similar but smaller heterogeneous cones and fans may form along breaks at the base of forested DG slopes.

SOILS

Most DG soils are moderately well to rapidly drained Brunisolics or Regosolics (Table 91). The most common soils are Orthic Eutric Brunisols. They are present on calcareous colluvium where stability has been sufficient for soil development (≥1000 years). Most Orthic Eutric Brunisols in DG have restricted or no A horizon development, B horizons that are weakly to moderately developed (little extractable iron, aluminum, and humus) and 5 to 30 cm thick, and moderately to extremely calcareous C horizons. The lower sola have a medium acid to mildly alkaline reaction (pH >5.5).

Regosolic soils interspersed with the Orthic Eutric Brunisols are at an incipient stage of development. On calcareous colluvium, geomorphic disturbance often severely retards soil development by exposing or incorporating into the solum fresh calcareous material. Orthic Regosols have little or no A or B horizon development. They are the subdominant element in DG1 and DG6, but are the majority in

DG3. Orthic Humic Regosols in DG3 probably result from surface disturbances that mechanically incorporate organic material into the topmost 10 cm (or more) of mineral material, creating an Ah horizon. Episodic deposition of mineral material buries organic-rich layers, generating Cumulic Regosols that are accessory soils in DG3. These soils usually occur on cones below couloirs.

Colluvium often is shallow, especially on steep slopes, and lithic phases are common. They are accessory characteristics of DG1 and DG6 and are typical of DG3 soils. Numerous nonsoil areas are interspersed with lithic soils in DG3, since bedrock crops out or is mantled by <10 cm of overburden over much of DG3.

Data on two typical pedons are in Tables D8 and D9. The first is an Orthic Eutric Brunisol, lithic phase, from a DG1 tract near Olive Lake (Plate 15). The high lime content of the colluvium has influenced profile development. Colors in the buried B horizons indicate some weathering, but carbonate is still the dominant factor. Lime distribution in the upper horizons shows that disturbance has retarded profile development. The high lime content corresponds with medium textures, both features being typical of colluvium derived from limestones.

The second pedon (Plate 16) is an Orthic Regosol from a DG3 tract east of the Sinclair-John McKay creek confluence. It also is lithic phase. Most DG3 soils are rapidly drained, as in this profile. It was sampled at a dry, exposed site in an area with considerable rock outcrop. Although more disturbed than the DG1 profile, the DG3 has a lower lime content. Textures are at the class boundary between medium and fine. The low lime content and textures are probably controlled by the local bedrock.

Both the DG1 and DG3 pedons have appreciable amounts of organic carbon within the solum. The horizons for which sufficient data are available nominally meet the requirements for a Bh horizon except that color values and chroma are too high. They were not designated Bh because the environment is dry and the vegetation atypical of Humic Podzols (C.S.S.C. 1978a).

VEGETATION

The various v.t.s in DG (Table 91) reflect differences in exposure, geomorphic activity, and fire history. The vegetation pattern in DG1 corresponds with aspect. Northerly aspects have the white spruce-Douglas fir/feathermoss (C5) v.t., while warmer and drier southerly aspects have Douglas fir/hairy wild rye (C1) v.t. (Plate 17). Lodgepole pine is an important canopy constituent on all aspects.

The lodgepole pine (***Pinus contorta***) forests of DG6 are usually younger than the Douglas fir (***Pseudotsuga menziesii***) forests of DG1. V.t. distribution in DG6 shows less influence of aspect. The lodgepole pine/buffaloberry/twinflower (C19) and lodgepole pine/buffaloberry/bunchberry (C39) v.t.s are typical, while lodgepole pine/buffaloberry/showy aster (C6) is an accessory.

The greatest diversity in vegetation occurs in DG3. The Douglas fir/juniper/bearberry (O5) v.t. is predominant (Plate 18), but Douglas fir-ponderosa pine/wheatgrass (O24) occurs on southerly aspects in the Stoddart Creek area. The most stable localities of DG3 resemble DG1 and have the Douglas fir/hairy wild rye (C1) v.t. Avalanched localities often have the aspen-dwarf birch/bearberry (S16). Bluebunch wheatgrass-hairy wild rye-showy aster (H19) is an important v.t. on southerly aspect DG3 tracts in semiarid southwestern KNP and is particularly abundant on DG3 near the mouth of Stoddart Creek (Plate 19). Unvegetated areas (<20% cover) are also an accessory feature of DG3, usually associated with steep bedrock outcrops.

WILDLIFE

DG1 Wildlife Features

Ungulates: DG1 is of high importance to mule deer year round, more so on southerly aspects with C1 forest than on northerly aspects dominated by C5 forest. DG1 is most important to wintering mule deer and, to a lesser extent, wintering elk in the Sinclair, John McKay and Stoddart creeks drainages. Browse use here is very high, primarily on red twin-berry (*Lonicera utahensis*), mountain maple (*Acer glabrum*), saskatoon (*Amelanchier alnifolia*) and false azalea (*Menziesia glabella*).

Carnivores: High prey densities and favorable snow conditions make DG1 very highly important year round. High densities of coyotes, cougars, lynx and weasels occur here.

Small Mammals: Associations 2 and 3.

This Ecosite has a large number of species occurring at high densities. High numbers of snowshoe hares, red squirrels, red-backed voles and deer mice were found here. This is the only Ecosite where a flying squirrel was captured.

Breeding Birds: Communities 3 and 19.

A high density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Wilson's Warbler and Hairy Woodpecker.

DG3 Wildlife Features

Ungulates: DG3 overall has a moderate importance in winter however, it is highly important to wintering mule deer in the Sinclair and Stoddart creeks areas. In addition, some tracts of DG3 are of very high importance to wintering bighorn sheep and mountain goats. Two DG3 tracts with bluebunch wheatgrass-hairy wild rye-showy aster (H19) and Douglas fir-ponderosa pine/bluebunch wheatgrass (O24) v.t.s in association with WY2 at Stoddart Creek, form the major winter range of the Radium Hot Springs bighorn sheep population. Other DG3 tracts along Palmer and Dry Gulch creeks may also be important to wintering sheep. The DG3 tract on the south facing, lower slope of Mount Wardle with open Douglas fir/juniper/bearberry (O5) and aspen-dwarf birch/bearberry (S16) v.t.s is very highly important as winter range for the Mount Wardle goat population (Poll and Porter 1984).

Carnivores: DG3 is moderately important overall, however it is highly important to cougars and coyotes in the Sinclair, Palmer, Dry Gulch and Stoddart creeks areas, especially in winter.

Small Mammals: Associations 1 and 2.

A moderate number of species occur here at moderate densities. Columbian ground squirrels and deer mice were found at high relative densities.

Breeding Birds: Community 3.

A medium density of birds was recorded. Species diversity is high. Based on density indices derived from circular census plots, this Ecosite is highly important to Rock Wren and Dusky Flycatcher.

DG6 Wildlife Features

Ungulates: DG6 is of high importance to mule deer, particularly in summer and fall, but of only moderate importance to elk and moose. With the exception of one DG6 tract with C44 v.t. which ranked high for moose in winter, DG6 is not used by wintering ungulates because of lower shrub production and higher snow accumulation relative to other DG Ecosites.

Carnivores: DG6 is highly important to coyotes in summer and to cougars in winter. It is also highly important to lynx.

Table 92. Wildlife features of DG Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
DG1	high	mule deer	very high	coyote lynx weasel cougar	high	hare red squirrel red-b. vole deer mouse	high
DG3	medium	mule deer sheep goat	medium	cougar	medium	Columbian gr. squirrel deer mouse chipmunk	medium
DG6	medium	mule deer	high	coyote lynx cougar	high	hare red squirrel red-b. vole	low

Small Mammals: Association 2.

A moderate number of species occur here at high densities. Red-backed voles were found at very high densities; snowshoe hares and red squirrels were found at high density.

Breeding Birds: Community 19.

A low density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Gray Jay and Pine Grosbeak.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The DG Ecosection concept originated with the KNP ecological inventory. Landscape similar to DG in BNP and JNP (Walker *et al.* 1982d) was included in the Norquay (NY) Ecosection, especially NY1X or NY3 + R tracts.

DG accounts for 4.9% of KNP, with DG1 being 2.0%, DG3 1.5% and DG6 1.4%. Sawback (SB) is the Lower Subalpine counterpart of DG, as both occur on predominantly calcareous colluvium. Steepness and colluviation are major limitations. The Ecosites from most to least active are: DG3 (craggy) and the others (forested). Southerly aspects are often droughty. Removal of vegetation may increase erosion.

DG is very important to wildlife as winter range for mule deer and bighorn sheep in the Sinclair-Stoddart watersheds. It contains a high diversity of birds and some occur only in this Ecosection. DG3 may be important for reptiles.

DR - DAER ECOSECTION

The Daer (DR) Ecosection concept incorporates: Montane forest vegetation; glacial landforms comprised of calcareous, medium to fine textured tills (Tills C and D) or calcareous, variably textured, ice contact stratified drift (Ice Contact Stratified Drift B); and moderately well to rapidly drained soils with Eutric Brunisols dominant and Gray Luvisols subdominant. The predominant vegetation includes closed forests of Douglas fir, white spruce-Douglas fir, lodgepole pine, aspen, and mixedwood. Eight DR Ecosites (Table 93) differ in vegetation and till *vs.* ice contact stratified drift materials or have complex, cartographically inseparable, landscape segments (northerly *vs.* southerly aspects, dry > wet landscape pattern). Figs. 17 and 18 illustrate topographic relationships among DR and other Ecosites.

Table 93. Definitive features of Daer (DR) Ecosites.

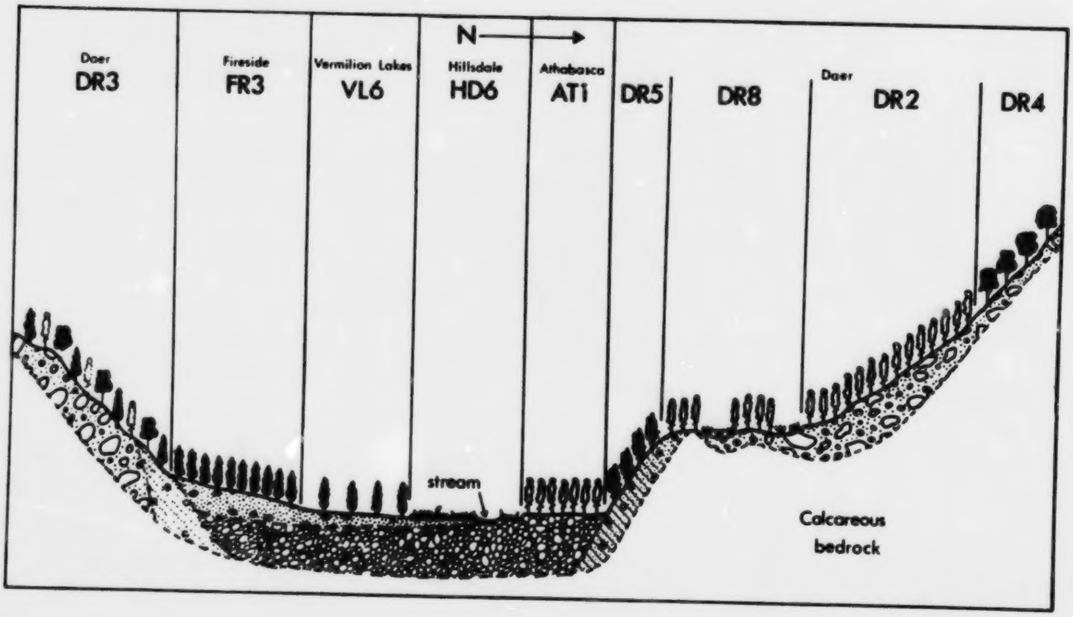
Ecosite	Landform	Soils	Vegetation
DR1	Tills C & D; veneer & blanket over inclined bedrock	Orthic Eutric Brunisol > Orthic Gray Luvisol	Douglas fir forest (C1)
DR2	Tills C & D; veneer & blanket over inclined & ridged bedrock	Orthic Eutric Brunisol > Eluviated Eutric Brunisol, Orthic Gray Luvisol	lodgepole pine forest (C38 > C10)
DR3	Tills C & D; veneer & blanket over inclined, hummocky & ridged bedrock	Orthic Eutric Brunisol > Eluviated Eutric Brunisol, Orthic Gray Luvisol	white spruce - Douglas fir forest (C5), mixedwood (C44)
DR4	Tills C & D; veneer over residual veneer over inclined bedrock	Lithic phases: Orthic Eutric Brunisol > Orthic Gray Luvisol	aspen forest (C16), mixedwood (C44) > lodgepole pine forest (C38)
DR5	Tills C & D, Ice Contact Stratified Drift B; veneer & blanket over inclined bedrock, inclined; gullied	Northerly: Orthic Eutric Brunisol > Eluviated Eutric Brunisol, Orthic Gray Luvisol	white spruce - Douglas fir forest (C5), white spruce forest (C37)
		Southerly: Orthic Eutric Brunisol > Orthic Gray Luvisol, Orthic Regosol	Douglas fir forest (C1)
DR6	Tills C & D, Ice Contact Stratified Drift B; veneer and blanket over ridged bedrock, hummocky & ridged	Dry^{70}: Orthic Eutric Brunisol > Eluviated Eutric Brunisol, Orthic Gray Luvisol	white spruce forest (C37), mixedwood (C44)
		Wet^{30}: Rego Gleysol, Terric Mesisol	wet spruce open forest (O11), wet shrubby meadow (S1)
DR7	Ice Contact Stratified Drift B; hummocky & ridged	Orthic Eutric Brunisol > Eluviated Eutric Brunisol, Orthic Gray Luvisol	lodgepole pine forest (C38)
DR8	Tills C & D, Ice Contact Stratified Drift B; veneer & blanket over ridged bedrock, hummocky & ridged	Dry^{70}: Orthic Eutric Brunisol > Eluviated Eutric Brunisol, Orthic Gray Luvisol	lodgepole pine forest (C38 > C39)
		Wet^{30}: Rego Gleysol, Terric Mesisol	wet shrubby meadow (S1) > wet spruce open forest (O11)

GEOMORPHOLOGY

DR is characterized by glacial landforms comprised of Tills C and D (calcareous, medium and fine textured respectively) and Ice Contact Stratified Drift B (calcareous, variably textured). These are derived mainly from McKay Group shale, slate, and limestone in the Kootenay and Columbia river valleys and from lower Chancellor Formation and other limestone strata in the Vermilion River valley. Definitive genetic material units and landform surface expressions for each DR Ecosite are in Table 93.

In the Kootenay River valley, tills often overlie residuum weathered from underlying soft bedrock. The residual veneers are mostly Residuum C (calcareous, fine textured) and contain clasts too soft to be coarse fragments. Lesser amounts of Residuum B (calcareous, medium textured) occur where the underlying bedrock is harder and coarser grained. It is often difficult to differentiate Residuum C from the overlying tills, and textures of both commonly range from silt loam to silty clay loam. Occasionally, residuum also underlies the ice contact stratified drift deposits. At a few sites, glacial materials are absent and residuum or bedrock is exposed.

Fig. 18. Landscape schematic of topographic relationships among DR and other Ecosites.



Ice Contact Stratified Drift B is a random mixture of morainal, glaciofluvial and, less frequently, glaciolacustrine sediments individually inseparable at the 1:50,000 scale. DR contains no extensive areas of glaciolacustrine veneers or blankets as in some Lower Subalpine BY4 and BY7 tracts. There are some large areas of glaciofluvial deposit that may supply aggregate (*e.g.* the borrow pit near Hector Gorge Lookout). Ice Contact Stratified Drift B is an accessory landform of DR3 and is abundant in a few tracts such as the DR3/5c tract around Cobb Lake.

Colluvial materials C and D (calcareous, medium and fine textured respectively), derived locally from glacial materials and bedrock and occurring as veneers, are important accessory materials associated with the steeply sloping DR5 Ecosite. Wet depressional segments (about 30%) of the dry > wet landscape patterns characteristic of DR6 and DR8 often have fluvial and fluviolacustrine veneers mantled by fen peat. The water-laid deposits are usually Fluvial material B (calcareous, coarse-stratified) and Fluviolacustrine material B (calcareous, fine-stratified). The discontinuous, moderately to well decomposed, organic material is fen peat even though fen vegetation has often been succeeded by open forest. Where the peat is >40 cm thick, the landform is horizontal fen (C.S.S.C. 1978a). Eolian material B (altered, medium textured) occurs occasionally as a thin, discontinuous veneer mantling glacial materials. Although of limited extent, it is most abundant on gentle slopes in the wind gap area from Luxor Pass to the lower slopes of Mount Shanks.

Surface expression of the morainal landforms usually reflects the underlying bedrock surface which is only subtly masked by either a morainal blanket or veneer. Long, straight inclined slopes ranging from 30 to 70% are typical of valley wall positions and DR1 and DR4. Irregular, ridged and hummocky slopes of 5 to 45% are characteristic of valley benchlands. DR2 and DR3 were mapped with both straight and irregular slopes from valley walls to benchlands. Ice contact stratified drift forms moraine-like landforms on valley floor benchlands. Surface form is usually of depositional origin, *e.g.* kames, kettles, and eskers, although shallower deposits overlying bedrock occur occasionally. Hummocky and ridged surfaces, with complex slopes ranging from 2 to 45%, are typical. Small terraces are included in some tracts. DR6 and DR8 occur on both morainal and ice contact stratified drift landforms of valley benchlands. DR7 also occurs on benchland positions but occurs primarily on ice contact stratified drift.

DR5 has steep (45-70%), short, straight slopes produced by the action of present or historical streams on glacial deposits of valley benchlands and walls. DR5 is mapped as two opposing erosional scarps separated by a narrow fluvial plain or as a single erosional scarp bounded upslope by glacial landforms, below by broad glaciofluvial terraces or fluvial floodplains on the valley bottomland. The erosional slopes are inclined and the fluvial deposits may be deep or shallow over bedrock. Occasionally, appreciable amounts of bedrock have been exposed by erosion (*e.g.* DR5 + R tract along Whitetail Creek). Gullies oriented perpendicular to the contour dissect the steep DR5 slopes. Gullied land may also occur in DR1, DR2, DR3, and DR4.

SOILS

Soils characteristic of the DR Ecosection are moderately well to rapidly drained and distributed in a pattern in which Eutric Brunisols are dominant and Gray Luvisols subdominant. Definitive soils subgroup patterns of each DR Ecosite are in Table 93. Although there are taxonomic differences, the soils are closely related because their characteristics are grouped around a taxonomic boundary. The Eutric Brunisols often have luvisol-like Bm or Btj horizons with poorer structure and clay film development than in Bt horizons of neighboring Gray Luvisols. Occurrences of the two great groups are unpredictable except that Gray Luvisols are more common on benchlands than on the steeper sloping valley walls above. Eluvial (Ae) horizon thickness varies among these soils and Eutric Brunisols are divided into Orthic (little or no Ae) and Eluviated (≥2 cm Ae) subgroups on the basis of Ae development and thickness. While Orthic Eutric Brunisols are dominant overall, Eluviated Eutric Brunisols occur most often on gently sloping terrain and under moist spruce, spruce-Douglas fir, and mixedwood forests. They are therefore included among the subdominant soils of DR2, DR3, DR5, DR6, DR7, and DR8. Ae horizons are effectively absent from the steeply sloping, comparatively dry DR1 and DR4 Ecosites. A pedon, (Table D10, Plate 20), illustrating the subdominant soils of DR, is from a DR2 tract near Hector Gorge. It also illustrates the till over residual parent material sequence common to many DR soils.

Accessory soils on the drier upland segments include Orthic Regosols in DR1; Brunisolic Gray Luvisols in DR3, DR6, DR7 and DR8; and Gleyed Eutric Brunisols in DR3 and DR6. Orthic Regosols, also among the subdominant soils of DR5 southerly aspects, are associated with erosional and depositional processes on steep, dry slopes. Brunisolic Gray Luvisols occur infrequently, have ***bisequa*** morphologies (a Bm horizon over a 2Bt horizon), and are usually associated with Eolian material B veneers. Gleyed Eutric Brunisols occur in local seepy terrain or in sites transitional between dry and wet segments. Lithic phase (shallow to bedrock) soils occur sporadically in most DR Ecosites, are accessory soil features in DR5 and are typical in DR4.

Wetland covers approximately 30% of DR6 and DR8 and normally occurs in inter-ridge and hummock depressions. High water tables, surface water collection and seepage account for the poorly to very poorly drained soils. Long periods of saturation and deposition of fluvial and fluviolacustrine materials inhibit pedogenic horizonation and the soils are Rego Gleysols. Orthic Gleysols occur as accessory soils in localities with shorter periods of saturation and little or no fluvial veneer. In the absence of mineral material sedimentation, the Gleysolic soils may have peaty surface horizons. Prolonged ponding and fen vegetation, occurring where fluvial deposition has long since ceased, have promoted the accumulation of thick fen peat. Where >40 cm thick, the soils are Organics, mostly Terric Mesisols.

VEGETATION

DR landscapes are vegetationally divided according to dominance by Douglas fir (DR5 southerly aspects and DR1), aspen (DR4), lodgepole pine (DR8 dry upland segments, DR2, and DR7) and white spruce (DR5 northerly aspects, DR6 dry upland segments, and DR3). Because of scale limitations and similar geomorphic origins, northerly and southerly aspects of DR5 were conceptually united as one Ecosite. Further, DR6 and DR8 with dry > wet landscape patterns have about 30% wetland vegetation. Characteristic v.t.s are in Table 93.

The Douglas fir/hairy wild rye (C1) v.t. dominates DR1 and southerly aspects of DR5. Aspects usually range from southeast through south to west and the soils are dry, and well to rapidly drained. Some lodgepole pine trees are intermixed and there are intergrades with the lodgepole pine/juniper/bearberry (C3) v.t. Lodgepole pine/buffaloberry/pinegrass (C38) is an accessory v.t. on DR5.

Aspen dominated DR4 (Plate 21) has a distinctive, random pattern of v.t.s in which aspen/hairy wild rye-peavine (C16), and spruce-aspen-lodgepole pine-(paper birch)/buffaloberry/pine grass (C44) are dominant and lodgepole pine/buffaloberry/pinegrass (C38) is subdominant. Here C44 contains more aspen and fewer white spruce than the modal concept. Paper birch *Betula papyrifera* may be present and one tract near the south boundary above the Cross River Fire Road is dominated by birch forest. Lodgepole pine forest, mainly C38, occurs randomly in patches. Accessory v.t.s are C1 on dry sites and lodgepole pine/green alder/feathermoss (C10) along some gullies. Aspects on DR4 commonly range from south to west and the soils are well drained and shallow (lithic phases).

DR2, DR7, and dry upland segments of DR8 are characterized by lodgepole pine forest. Lodgepole pine/buffaloberry/pinegrass (C38) is the predominant v.t. (Plate 22) Lodgepole pine/green alder/feathermoss (C10) and lodgepole pine/buffaloberry/bunchberry (C39) are subdominant v.t.s of DR2 and DR8, respectively. C10 is an accessory v.t. of DR7 and DR8. C39 is an accessory v.t. of DR2 and DR7. Other accessory v.t.s of the widely distributed DR2 Ecosite are lodgepole pine/feathermoss (C11), lodgepole pine/buffaloberry/twinflower (C19), and white spruce-western larch-Douglas fir/bunchberry (C45). C45 is the most distinctive and occurs on at least one tract, a DR2/7c near Highway 93 and Swede Creek. DR landscapes with lodgepole pine occur on all aspects but are most extensive on the warmer, drier southeast to west aspects. Associated soils are mainly well drained.

DR3, northerly aspects of DR5 and dry upland segments of DR6 are characterized by v.t.s in which spruce is dominant or codominant. *i.e.* white spruce-Douglas fir/feathermoss (C5), white spruce/buffaloberry/feathermoss (C37), and spruce-aspen-lodgepole pine-(paper birch)/buffaloberry/pine grass (C44) (Table 93). Accessory v.t.s of DR3 are Engelmann spruce-subalpine fir/feathermoss (C13), Engelmann spruce-subalpine fir/green alder (C25), white spruce/buffaloberry/feathermoss (C37), and white spruce-western larch-Douglas fir/bunchberry (C45). C13 and C45 are accessory v.t.s of DR5; C5 and C25 of DR6. C13 and C25 occur at high elevations that are transitional to Lower Subalpine and the Engelmann spruce-subalpine fir canopy of C13 is often replaced by white spruce and spruce hybrids. C45 is a distinctive v.t. which is particularly visible in the fall. Stands are most abundant around Cobb Lake and Swede Creek but extend as far north as Kootenay Crossing below Luxor Pass. DR landscapes with spruce forests occur on all aspects but are most extensive on northerly to easterly aspects on the west sides of major rivers. Associated soils are mainly well to moderately well drained.

Wetland segments of DR6 and DR8, with poorly to very poorly drained soils, are dominated by the wet spruce/Labrador tea/brown moss (O11) and dwarf birch-shrubby cinquefoil-willow/brown moss (S1) v.t.s. Engelmann spruce-subalpine fir/willow/ribbed bog moss (O6, Corns and Achuff 1982) and dwarf birch-shrubby cinquefoil/needlerush (S3, Corns and Achuff 1982) occur infrequently but are similar to the dominants and are listed as accessory v.t.s. Another accessory v.t., water sedge-beaked sedge (H11), occurs in ponded localities and is often associated with the margins of lakes and ponds that are included in some DR6 and DR8 tracts.

WILDLIFE

DR1 Wildlife Features

Ungulates: DR1 is highly important to elk and deer year round, particularly to elk during winter in the lower Kootenay Valley and to mule deer in winter in the Sinclair and Stoddart drainages. DR1 is also moderately important to bighorn sheep during winter in the lower Sinclair and Stoddart drainages, particularly in association with WY1 and WY2. Browse use is moderate with heaviest use on saskatoon (***Amelanchier alnifolia***) and prickly rose (***Rosa acicularis***).

Carnivores: Abundance of prey species and favorable snow conditions in most winters, make DR1 highly important all year, particularly for coyotes, cougars and lynx.

Small Mammals: Association 2.
A moderate number of species occurs here at high densities. Snowshoe hares, Columbian ground squirrels, red-backed voles and deer mice occur in high numbers.

Breeding Birds: Community 3.
A medium density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Golden-crowned Kinglet, Mountain Chickadee, and Wilson's Warbler.

DR2 Wildlife Features

Ungulates: DR2 is of high importance, especially to elk in winter and deer in late summer and fall. It is also highly important to wintering mule deer along Sinclair Creek. One tract (DR2FA) on the lower, south aspect of Mount Wardle is important as a travel route to a major lick used by mountain goats in the summer. Browse use by ungulates is moderate. Heaviest browsing is on aspen (***Populus tremuloides***), saskatoon (***Amelanchier alnifolia***) and mountain maple (***Acer glabrum***).

Carnivores: The importance of DR2 is high for the same reasons as for DR1. High use by cougars, lynx and weasels occurs on some tracts. Wolves used this Ecosite in the Kootenay Ponds area during winter 1982-83.

Small Mammals: Associations 2 and 3.
The large number of v.t.s on DR3 results in a high species diversity. Porcupines, red squirrels, red-backed voles and deer mice occur at high densities.

Breeding Birds: Communities 1, 5 and 19.
A medium density of birds was recorded. Species diversity is high. Based on density indices derived from circular census plots, this Ecosite is highly important to Yellow-rumped Warbler, Swainson's Thrush, Steller's Jay, and Orange-crowned Warbler.

DR3 Wildlife Features

Ungulates: DR3 is highly important to elk, moose and deer in winter, primarily where spruce-aspen-lodgepole pine-(paper birch)/buffaloberry/pine grass (C44) occurs. It is high for mule deer and elk in winter along Sinclair Creek, particularly where associated with Highway 93, and high for white-tailed deer in summer and fall in the Kootenay Valley. Browse use is high in C44, C5, and C37 v.t.'s. Most commonly browsed species include mountain maple (***Acer glabrum***), saskatoon (***Amelanchier alnifolia***), white meadowsweet (***Spiraea lucida***) and low-bush cranberry (***Viburnum edule***).

Table 94. Wildlife features of DR Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
DR1	high	elk deer	high	coyote lynx cougar	high	hare Columbian gr. squirrel red-b. vole	medium
DR2	high	elk deer	high	weasel lynx cougar	medium	hare	medium
DR3	high	elk moose deer	high	cougar marten	high	porcupine red squirrel red-b. vole	medium
DR4	very high	elk moose deer	high	coyote cougar	medium	deer mouse	high
DR5	high	moose	high	coyote cougar	very high	hare Columbian gr. squirrel red squirrel red-b. vole	low
DR6	high	elk moose	high	cougar	medium	beaver red-b. vole meadow vole	high
DR7	medium	deer	medium	cougar	medium		medium
DR8	medium	deer	high	coyote cougar	high	red squirrel hare	medium

Carnivores: DR3 is highly important to cougars in winter, especially in the Sinclair Creek area because of the high occurrence of mule deer and elk. Martens occur in high numbers on some tracts.

Small Mammals: Associations 2 and 3.
The large number of v.t.s on DR3 results in a high species diversity. Porcupines, red squirrels, red-backed voles and deer mice occur at high densities.

Breeding Birds: Communities 1, 5, 8 and 19.
A medium density of birds was recorded. Species diversity is high. Based on density indices derived from circular census plots, this Ecosite is highly important to Townsend's Warbler and Golden-crowned Kinglet.

DR4 Wildlife Features

Ungulates: DR4, largely due to the dominance of either aspen/hairy wild rye-peavine (C16) or spruce-aspen-lodgepole pine-(paper birch)/buffaloberry/pine grass (C44) forest is very highly important year round. DR4, especially with a C16 v.t., has a limited distribution within KNP, occurring primarily in the Daer Fire Tower area and along the lower Cross River fire road. These areas are very important to elk and moose, particularly in winter and to mule deer and white-tailed deer in summer and fall. A few tracts of DR4 with C1 and C44 v.t. occur along Sinclair Creek and are highly important to wintering mule deer and moderately important to bighorn sheep in association with WY1, WY2 and DR5 Ecosites. Use by bighorn sheep also occurs in DR4 in the Daer Tower area. Browse use is high in C44 and moderate in C16. Highest use was recorded on aspen (*Populus tremuloides*), mountain maple (*Acer glabrum*), saskatoon (*Amelanchier alnifolia*) and red-osier dogwood (*Cornus stolonifera*).

Carnivores: High prey availability year round makes DR4 highly important, particularly to coyotes and cougars.

Small Mammals: Associations 1 and 2.
A moderate number of species occurs here at moderate density. Only deer mice occur in high numbers.
Breeding Birds: Communities 1, 3 and 19.
A high density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Yellow-rumped Warbler, Dark-eyed Junco, Evening Grosbeak, Mountain Chickadee, Townsend's Solitaire, Warbling Vireo, Swainson's Thrush, Red Crossbill and Orange-crowned Warbler.

DR5 Wildlife Features

Ungulates: DR5, due to its association with stream channels, is very highly important to moose in winter. The DR5 tract along lower Sinclair Creek (John McKay Creek to Sinclair Canyon) is very highly important to bighorn sheep because of the large amount of man-made grassland surrounding park and commercial developments. Sheep are also attracted to the highway surface by salt residues. Browse use is high in C5 and C37 v.t.s and moderate in C1.
Carnivores: DR5 is highly important because of high prey availability. Cougar use is most frequent in the Sinclair and John McKay creeks areas where mule deer and bighorn sheep are abundant. Coyote use is also high here during winter and wolves made moderate use of DR5 during winter 1982-83.
Small Mammals: Associations 2 and 3.
A high number of species occurs here at high densities. Species occurring at high densities include: snowshoe hares, red squirrels, Columbian ground squirrels, red-backed voles and deer mice.
Breeding Birds: Communities 1, 3, 5 and 19.
A low density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Townsend's Warbler.

DR6 Wildlife Features

Ungulates: DR6 is highly important, particularly to moose and elk in winter. The v.t. mosaic of forest and shrub meadow provides excellent foraging habitat. Browse use is high in all v.t.'s sampled (C37, C44, O6, O11, S1) and highest in O11 and S1. Browsing is heaviest on willow (*Salix* spp.), dwarf birch (***Betula glandulosa***), prickly rose (***Rosa acicularis***) and aspen (***Populus tremuloides***). Elk particularly make heavy use of sedges (***Carex aquatilis, Carex rostrata, Carex*** spp.) in O11, S1 and H11 v.t.s. during winter.
Carnivores: As with the other DR Ecosites, high prey availability and favorable snow conditions in most winters, make DR6 highly important. This was also one of two Ecosites where mink and fisher tracts were observed.
Small Mammals: Associations 2, 3 and 4.
High habitat diversity promotes high species diversity, however most species occur at moderate to low densities. Red-backed voles, meadow voles, and yellow-pine chipmunks occur in high numbers. DR6 is also important to beaver, especially along Dolly Varden Creek.
Breeding Birds: Communities 1, 5, 6, 8, 12 and 19.
A high density of birds was recorded. Species diversity is high. Based on density indices derived from circular census plots, this Ecosite is highly important to Yellow-bellied Sapsucker, Rufous Hummingbird, Red-breasted Nuthatch, Red Crossbill, Black-capped Chickadee, Belted Kingfisher, Common Snipe, Common Yellowthroat and Hairy Woodpecker.

DR7 Wildlife Features

Ungulates: DR7 is of moderate importance overall in winter, but of high importance to deer (primarily white-tailed deer) in spring and summer. White-tailed deer make particularly heavy use of DR7 along Settler's Road (as a travel corridor in spring and fall) and adjacent to Highway 93. DR7 in the Kootenay Ponds area is of high importance to elk in winter because of the shrub/sedge communities associated with these wetlands. Mountain goats make high use of the DR7 tract at the base of Mount Wardle as a travel route to the lick areas adjacent Highway 93. Overall browse use is low.

Carnivores: DR7 is moderately important overall and highly important to cougars in winter. Wolves used a DR7 tract at the base of the south facing slope of Mount Wardle during winter 1982-83.

Small Mammals: Associations 2 and 3.
A moderate number of species occurs here at moderate densities.

Breeding Birds: Communities 1 and 19.
A medium density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Cedar Waxwing, Evening Grosbeak, Dark-eyed Junco, Hammond's Flycatcher, and Solitary Vireo.

DR8 Wildlife Features

Ungulates: The overall importance of this lodgepole pine (*Pinus contorta*) dominated Ecosite is only moderate. However, the wet-dry mosaic is similar to DR6 and use by elk and moose is high in S1 and O11 v.t.s during winter The highest importance is to white-tailed deer in summer, particularly in association with Highway 93, but also along Dolly Varden Creek and the upper Kootenay River. Browse and forage use is high in O11, O6, S1 and H11.

Carnivores: DR8 is highly important. It is highly important to coyote year round, particularly where associated with Highway 93. Cougars were observed here during winter, more than in any other DR Ecosite (Warden wildlife records). This is one of two Ecosites where mink tracks were observed.

Small Mammals: Associations 2, 3 and 4.
The importance of DR8 stems from a high habitat diversity. A high number of species occurs at moderate to high densities. Red squirrels occur at very high density and snowshoe hares at high density.

Breeding Birds: Communities 1, 6, 12 and 19.
A medium density of birds was recorded. Species diversity is high. Based on density indices derived from circular census plots, this Ecosite is highly important to American Robin, Hammond's Flycatcher, Steller's Jay, Chipping Sparrow and Tree Swallow.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

DR covers 19.0% of KNP and resembles the Patricia (PT) Ecosection of the BNP and JNP ecological inventory. Textural differences reflecting associated bedrock warranted the Ecosection separation. PT is characterized by coarser textured till (Till C) derived from resistant limestones.

DR1 (1.9%) and DR5 (2.1%) resemble the Wycliffe 1 and 2 (WY1 and WY2) Ecosites, respectively. WY Ecosites, however, are generally restricted to the warm, dry mesoclimate below 1250 m in southwestern KNP (see Climate, Chap. I). They have thin sola, weakly developed soils and few to no Luvisolic soils. Further, southerly aspects and exposed slopes of WY2 are dominated by Regosolic and Chernozemic soils under Douglas fir open forest and grassland. There are no other Montane glacial landscapes that resemble DR2 (5.4%), DR3 (2.8%), DR4 (1.1%), DR6 (1.6%), DR7 (2.2%) and DR8 (2.0%). Parts of Dry Gulch 1 and 6 (DG1 and DG6) have soils and vegetation similar to DR1, DR2 and DR3 but occur on steeper colluvial landforms.

The two segments comprising the compound DR5, DR6, and DR8 Ecosites (Table 93) could be mapped separately at scales larger than 1:50,000. The northerly aspect segment of DR5 and dry upland segment of DR6 become DR3, the southerly aspect segment of DR5 becomes DR1, the dry upland segment of DR8 becomes DR2 or DR7, and wetland segments of DR6 and DR8 resemble Vermilion Lakes 2 and 6 (VL2 and VL6).

Use is limited by steep slopes or irrregular topography. Locally, use may be affected by wet depressions, gullies, shallow soils and gravelly coarse textured ice contact deposits. Removal of vegetation may result in erosion on steep slopes.

DR is very important to wildlife because of high habitat diversity. Critical elk and moose winter range and important deer summer range occur here. High prey densities support many carnivores. High bird diversity results from the vegetation mosaic.

EF - EIFFEL ECOSECTION

The Eiffel (EF) Ecosection concept includes: Alpine tundra vegetation and morainal landforms comprised of noncalcareous, coarse textured till (Till A) derived from Gog Group quartzites. Dystric and Sombric Brunisols and Podzols are the characteristic soils. Only one Ecosite (EF1, Table 95) was recognized and only two tracts were mapped in KNP. The concept was taken from the BNP and JNP ecological inventory (Walker *et al.* 1982d) where EF1 is more extensive. Both tracts occur in the eastern Main Ranges; one on a spur ridge of Storm Moutain, the other on a valley shoulder above upper Tokumm Creek. Fig. 21 illustrates the topographic relationship of EF1 to its Upper Subalpine counterparts, Larch Valley 2 and 3 (LV2 and LV3).

GEOMORPHOLOGY

EF is geomorphically characterized by morainal landforms comprised of Till A (noncalcareous, coarse textured). The till occurs as veneers and blankets overlying inclined, hummocky and ridged bedrock. Topography is complex with slopes of 15 to 45%. Inclined slopes characterize the lower fringes of both tracts and grade upwards to hummocky or ridged topography. Thin, discontinuous veneers of Eolian material B (altered, medium textured) mantle the morainal material.

SOILS

The well drained, deeply weathered, well developed soils that characterize EF1 reflect the acidic, coarse textured, parent material; humus accumulation in upper sola; the presence of Eolian material B; and the cool, moist, Alpine environment. The various taxa (Table 95) have characteristics grouped around taxonomic boundaries. B horizon development is strong and ranges from Bm and Bf (Brunisolic soils) to podzolic Bf (Podzolic soils). Bf and podzolic Bf horizons are more likely to develop where Eolian material B is a significant constituent of upper sola. Bhf and podzolic Bhf (Orthic Ferro-Humic Podzols) horizons also occur, based on BNP and JNP data, and the classification at the great group level of EF1 Podzolic soils is often tenuous when based on field characteristics alone. EF1 soils may be weakly cemented (duric tendency) in lower sola.

Eluvial (Ae) horizon thickness and development also varies across the landscape. Dystric Brunisols are the only soil group of EF1 divided, according to Ae horizon thickness, into Orthic (little or no Ae) and Eluviated ($\geq$2 cm Ae) subgroups. The best developed, thickest Ae horizons occur where there is little or no Eolian material B. Ae horizon development may be obscured by humus incorporation under tundra vegetation. Thus, Ah and Ahe horizons often occur and where Ah horizons are $\geq$10 cm thick, the soils are Orthic Sombric Brunisol.

Due to various horizon combinations and thicknesses, Sombric Humo-Ferric Podzols, Sombric Ferro-Humic Podzols and Eluviated Sombric Brunisols may also occur in minor amounts. Lithic phases occur occasionally and are associated with morainal veneers. An Orthic Humo-Ferric Podzol pedon (Table D11, Plate 23) illustrates EF1 soils. It is from Larch Valley in BNP, 5 km northeast of upper Tokumm Creek. Textures in the lower solum are slightly finer than modal for Till A, probably due to the inclusion of some non-quartzitic material. Also, the upper solum appears partially mixed, as indicated by the textural data, and probably includes some Eolian material B, especially in the Ah and Bf horizons. Otherwise, the pedon is similar to EF1 soils in KNP.

Table 95. Definitive features of Eiffel (EF) Ecosites.

Ecosite	Landform	Soils	Vegetation
EF1	Till A; veneer & blanket over inclined, hummocky & ridged bedrock	Orthic & Eluviated Dystric Brunisols, Orthic Sombric Brunisol, Orthic Humo-Ferric Podzol	heath tundra (L5)

VEGETATION

EF1 is dominated by the heather-everlasting (L5) v.t. The mountain avens-snow willow-moss campion (H1) v.t. occurs occasionally as an accessory v.t. and is restricted to exposed, wind-swept, hummock and ridge crests. A few krummholz trees, mainly subalpine larch, are included in the EF1 tract in Tokumm Creek valley.

WILDLIFE

EF1 Wildlife Features

Ungulates: Only two EF1 tracts occur in KNP and both are moderately important to mountain goats year round.
Carnivores: EF1 is of low importance.
Small Mammals: Associations 5 and 6.
A moderate number of species occurs at moderate densities. Columbian ground squirrels occur at high densities.
Breeding Birds: Communities 17 and 18.
A low density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Rosy Finch and Water Pipit.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The EF1 concept was developed in the BNP and JNP and applied to identical landscape (<0.1%) in KNP. EF is the Alpine counterpart of the Upper Subalpine Larch Valley (LV) Ecosection. Jonas 1 (JN1) resembles EF1 but occurs on non- to weakly calcareous, medium textured, morainal material (Till B) derived from slaty bedrock.

Use is limited by coarse textures and where slopes are steep or topography is irregular. Locally, use may be affected by stony surfaces and gullies. Removal of vegetation may result in erosion on steep slopes and revegetation will be slow.

EF is of low importance to wildlife. It is used moderately by mountain goats year round.

Table 96. Wildlife features of EF Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
EF1	low		low		medium	marmot Columbian gr. squirrel	low

EG - EGYPT ECOSECTION

The Egypt (EG) Ecosection concept incorporates: Upper Subalpine vegetation; morainal landforms of non- to weakly calcareous, medium textured till (Till B), and well to moderately well drained, acidic soils, mostly Dystric Brunisols. Vegetation ranges from Engelmann spruce-subalpine fir forest at low elevations through subalpine larch forest to a pattern of heath tundra plus subalpine larch open forest at high elevations. Four EG Ecosites (Table 97) were differentiated, primarily on vegetation patterns and a dry > wet landscape pattern. EG occurs in the Main Ranges, usually in cirques and passes, high on valley walls and, occasionally, along valley floors. Fig. 19 illustrates topographic relationships among EG and some other Ecosites.

Fig. 19. Landscape schematic of topographic relationships among EG and other Ecosites.

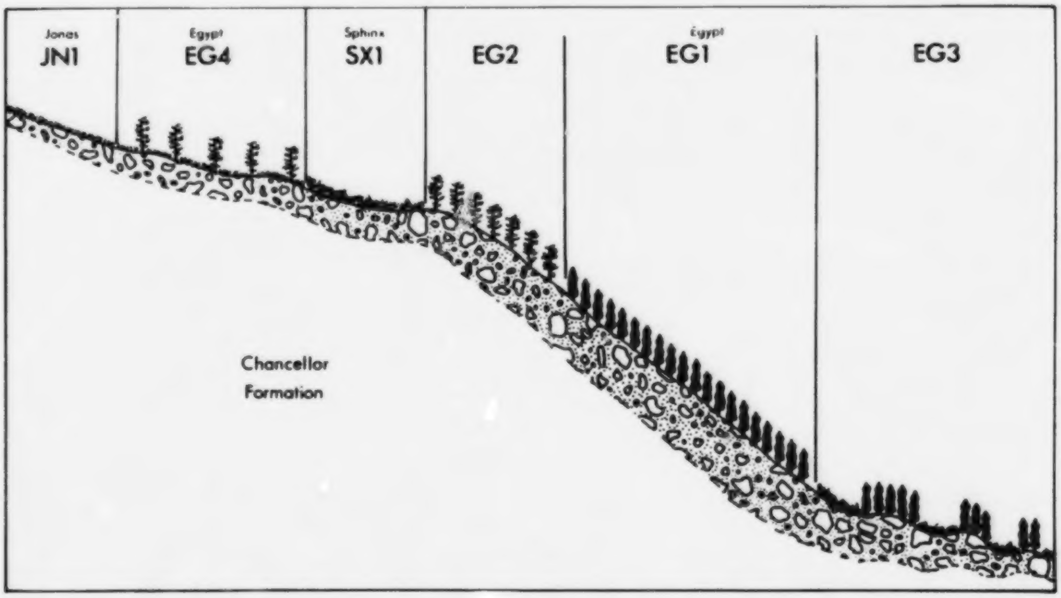


Table 97. Definitive features of Egypt (EG) Ecosites.

Eco-site	Landform	Soils	Vegetation
EG1	Till B; veneer & blanket over inclined, hummocky & ridged bedrock	Eluviated Dystric Brunisol > Orthic Dystric Brunisol, Orthic Humo-Ferric Podzol	Engelmann spruce-subalpine fir forest (C21 > C15)
EG2	Till B; veneer & blanket over inclined, hummocky & ridged bedrock	Eluviated Dystric Brunisol > Orthic Humo-Ferric Podzol	subalpine larch-subalpine fir forest (C23)
EG3	Till B; veneer & blanket over hummocky & ridged bedrock	Dry^{70}: Eluviated Dystric Brunisol > Orthic Humo-Ferric Podzol Wet^{30}: Gleyed Dystric Brunisol, Gleyed Ferro-Humic Podzol, Gleyed Sombric Brunisol	Engelmann spruce-subalpine fir forest (C21), subalpine larch-subalpine fir forest (C23), subalpine larch open forest (O13) moist Engelmann spruce-subalpine fir open forest (O9), moist herb meadow (H16), herb tundra (H17)
EG4	Till B; veneer & blanket over inclined, hummocky & ridged bedrock	Orthic & Eluviated Dystric Brunisols > Orthic Humo-Ferric Podzol	heath tundra (L5) > subalpine larch open forest (O13)

GEOMORPHOLOGY

EG is geomorphically characterized by morainal landforms of Till B (non- to weakly calcareous, medium textured). Most EG is in the western Main Ranges where the till is derived from Chancellor Formation slate. Till C (calcareous, medium textured) also occurs in minor amounts, particularly in tracts near the boundary between western and eastern Main Ranges. Four tracts are in East Verdant Creek valley in the eastern Main Ranges where the Till B with one exception, is derived from Miette Group slate. The exception, an EG3 tract at Red Earth Pass, contains Till A and possibly some Ice Contact Stratified Drift C (non- to weakly calcareous, variably textured). The latter material may also be present in EG3 at Ottertail Pass. Only one tract, EG1B in the Whitetail Creek valley, occurs west of the Vermilion/Mitchell Ranges on McKay Group bedrock. Whether Miette or McKay Group or Chancellor Formation, the slaty bedrock is recessive and the mountain topography subdued. The top of the bedrock is often weathered to a veneer of Residuum A (non- to weakly calcareous, medium textured) sandwiched between the till above and bedrock below. On a few sites, till is absent and the residuum or bedrock is exposed.

Eolian material B (altered, medium textured) is a common constituent of EG landforms. It occurs as a thin, discontinuous veneer mantling the till or, more often, as an eolian-till mixture generated by solifluction, soil creep and tree throw. Wet depressional segments (about 30%) of the dry > wet landscape pattern of EG3 often have a thin fluviolacustrine veneer over till. This veneer is predominantly Fluviolacustrine material A (altered, fine-stratified) derived locally by slope wash and stream deposition. Redeposited Eolian material B is probably a main constituent of the veneer.

The morainal material commonly occurs as a veneer or blanket and the surface expressions (Table 97) reflect underlying bedrock. The longest slopes (30-70%) are straight, reflect inclined bedrock and occur on valley, cirque and pass walls. Hummocky or ridged topography, with slopes of 5 to 45%, is prevalent on the floors of passes, cirques and valleys. Tracts with the modifier X (*e.g.* EG2X south of Helmet Creek) are dominated by morainal veneer and lithic phase soils. Tracts with the modifier F have hummocky to ridged topography reflecting thick deposits of extinct rock glaciers (*e.g.* EG1F below Misko Pass) or bedrock failure (*e.g.* EG2F on Monarch Ramparts). Bedrock failure is only partial in the EG2F and EG4FX tracts on Monarch Ramparts and tension cracks appear where the overburden is shallow. These tracts have ridged, bench-like topography superimposed on an inclined slope. Other modifying processes, mainly solifluction, have occasionally affected the soils.

SOILS

EG is characterized by well to moderately well drained, moderately to well developed soils which reflect the acidic to neutral, medium textured, parent material; the presence of Eolian material B; humus accumulation in upper sola at high elevations; and the cool, moist, Upper Subalpine environment. The various soils (Table 97) have characteristics grouped around taxonomic boundaries. B horizon development is moderate to strong and ranges from Bm and Bf (Brunisolics) to podzolic Bf (Podzolics). Bf and podzolic Bf are more likely to develop where Eolian material B is a significant constituent of upper sola. Soils with Bhf and podzolic Bhf (Orthic Ferro-Humic Podzols) horizons also occur occasionally and the classification of EG4 Podzolic soils at the great group level is often tenuous (Walker *et al.* 1982d) when based on field characteristics alone.

A horizon development also varies across the landscape, depending on humus incorporation, surficial material, slope gradient, and surface disturbances. Thin Ae horizons occur most often, particularly under closed forest. At other sites, A horizons may be absent or thin Ah, Ahe or AB horizons (Plate 24) may replace Ae, particularly under the heath tundra plus larch open forest pattern of EG4. Dystric Brunisols are divided, according to Ae horizon thickness, into Eluviated (≥2 cm Ae) and Orthic (little or no Ae) subgroups. Orthic Sombric Brunisols, with Ah horizons ≥10 cm, occur as accessory soils in EG4. A pedon (Table D12), illustrating characteristics of EG soils, is from an EG3 tract near Floe Lake. It includes some eolian material mixed with till in the upper horizons, and has a higher than normal content of coarse fragments in lower horizons.

Other soils of limited distribution on well to moderately well drained segments of EG include Eluviated Eutric Brunisols associated with localized calcareous till, lithic phases where unconsolidated materials are shallow, and turbic phases where disturbances such as solifluction and tree throw have disrupted upper horizons. Lithic phases dominate tracts mapped with the modifier X (*e.g.* EG2X south of Helmet Creek). Turbic phases are more abundant in EG4 than the other EG Ecosites.

Wetland accounts for approximately 30% of EG3 and occurs in depressions. Seepage and surface water collection account for the imperfectly drained soils. Periods of saturation are short, usually only after snow melt and soil thaw, and the soils are only weakly to moderately gleyed. Otherwise, horizonation is similar to the drier upland soils except that humus incorporation and movement in the wetter soils is greater. Hence, Gleyed Ferro-Humic Podzols (with podzolic Bhf horizons) and Gleyed Sombric Brunisols (Ah horizons ≥10 cm) are codominant with Gleyed Dystric Brunisols. Gleyed Ferro-Humic Podzols best represent a range of Podzolic great groups that also includes Humo-Ferric and Humic Podzols. In some poorly drained depressions with longer saturation periods, Orthic Gleysols occur as accessory soils. Turbic phases also occur occasionally where solifluction and cryoturbation have disrupted upper horizons.

VEGETATION

EG1 is characterized by Engelmann spruce-subalpine fir forest in which Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) is the dominant v.t. and Engelmann spruce-subalpine fir/grouseberry (C15) is the subdominant v.t. Small stands of the Engelmann spruce-subalpine fir/heather/feathermoss (C34) v.t. occur occasionally. EG2 is dominated by the subalpine larch-subalpine fir/grouseberry-everlasting (C23) v.t. (Plate 25) which grades to narrow bands of subalpine larch-subalpine fir/heather (O13) v.t. along the upper elevational limits. Small stands of Engelmann spruce-subalpine fir, mainly C21 and C15, are occasionally interspersed with the subalpine larch forest. EG4 has a vegetation pattern in which the heather-everlasting (L5) v.t. is more abundant than the subalpine larch-subalpine fir/heather (O13) v.t. Subalpine larch in O13 normally occurs as widely separated trees or as patches of trees but includes krummholz on exposed sites or at the Upper Subalpine-Alpine boundary. In EG4, tree islands cover about 50% of the landscape at lowest elevations and 5% at the highest. The Engelmann spruce-subalpine fir/heather (O10) v.t., characteristic of EG4 in JNP and northern BNP occasionally replaces O13 in KNP and the everlasting-grouseberry (H17) v.t. occasionally occurs with or replaces L5.

Vegetation of EG3 is a composite of the other three EG Ecosites plus subdominant wetlands. Thus, the drier uplands have spruce-fir forest (C21 or less often C15), subalpine larch forest (C23) or subalpine larch open forest (O13), depending primarily on elevation. L5 also occurs occasionally. Wetlands have a variety of moist to wet v.t.s, the most common being Engelmann spruce-subalpine fir/valerian-fleabane (O9), fleabane-valerian (H16) and everlasting-grouseberry (H17). Accessory v.t.s on wetlands are O13, Engelmann spruce-subalpine fir/rock willow/bracted lousewort (O14) and arctic willow-cinquefoil (L7).

Tracts with the modifier **A** (*e.g.* EG1A above Floe Creek) have 20 to 50% of the area modified by snow avalanching. Modification is mainly to vegetation. Avalanche v.t.s such as subalpine fir-willow (S2) and fleabane-valerian (H16) occur on avalanche paths. A few tracts with the modifier **B** (*e.g.* EG1B on a branch of Whitetail Creek valley) have post-fire, successional vegetation.

WILDLIFE

EG1 Wildlife Features

Ungulates: EG1 is of low importance, however summer and fall use by mule deer, elk and moose was recorded.

Carnivores: EG1 is highly important to martens and moderately important to wolverines and lynx.

Small Mammals: Association 3.

A moderate number of species is found here. High densities of snowshoe hares and porcupines occur.

Breeding Birds: Community 8.

A medium density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Fox Sparrow, Hermit Thrush, Pine Grosbeak, Varied Thrush, and White-winged Crossbill.

EG2 Wildlife Features

Ungulates: EG2 is of low importance overall. However, low levels of summer and fall use were recorded for mule deer, elk and moose. High snow accumulation precludes winter use by ungulates.

Carnivores: As with EG1, EG2 is highly important, especially to martens. It is moderately important to larger carnivores.

Small Mammals: Associations 5 and 6.

A moderate number of species occurs at low densities.

Breeding Birds: Community 7.

A medium density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Chipping Sparrow, Clark's Nutcracker, Fox Sparrow, Mountain Chickadee, Varied Thrush, and Dark-eyed Junco.

Table 98. Wildlife features of EG Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
EG1	low		high	marten	high	hare porcupine	medium
EG2	low	goat	high	marten	low		medium
EG3	low		high	marten	high	hare	medium
EG4	low	goat	low		medium	Columbian gr. squirrel	medium

EG3 Wildlife Features

Ungulates: EG3 is of low importance. Deep snow prevents winter use. Open forest and wet meadow areas receive moderate use by elk and moose in summer.
Carnivores: EG3 supports a high number of carnivores and is highly important to martens.
Small Mammals: Associations 3, 5, 6 and 8.
The high diversity of small mammals makes EG3 highly important. Only snowshoe hares occur at high densities.
Breeding Birds: Communities 7, 8, 17 and 18.
A medium density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Fox Sparrow, Mountain Chickadee, Pine Grosbeak, Dark-eyed Junco, and Varied Thrush.

EG4 Wildlife Features

Ungulates: EG4 is of low importance overall, but moderately important to mountain goats year round. Deep snow prevents extensive winter use.
Carnivores: EG4 is of low importance.
Small Mammals: Associations 5 and 3.
EG4 supports a moderate number of species at low to moderate densities. Columbian ground squirrels occur at high densities.
Breeding Birds: Communities 7, 17 and 18.
A medium density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Rosy Finch.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The EG Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and modified slightly to accommodate similar landscape (2.7%) in KNP. Likewise, the EG1 (1.3%), EG2 (0.5%), EG3 (0.4%), and EG4 (0.5%) concepts were extended, with minor modification, to KNP.

EG is the Upper Subalpine counterpart of the Alpine Jonas (JN) and the Lower Subalpine Cavell (CA) Ecosections. The Larch Valley (LV) and Peyto Lake (PL) Ecosections resemble EG. However, LV occurs on the coarser textured Till A (noncalcareous, coarse textured). PL occurs on calcareous Till C (calcareous, medium textured) and is dominated by Eutric Brunisols. EG4 and Sphinx 1 (SX1) occasionally resemble each other, particularly on aerial photos, but SX1 has characteristics indicative of slightly wetter, seepage-induced conditions.

The two segments comprising the compound EG3 Ecosite (Table 97) can be separated at a mapping scale larger than 1:50,000. The drier, upland segment becomes mappable as EG1, EG2 or EG4 and the wetland segment becomes mappable as Sphinx 1 (SX1) or 2 (SX2).

Use is limited by steep slopes or irregular topography. Locally, use may be affected by wet depressions and seepage, shallow soils, and pedoturbation. Removal of vegetation may result in erosion on steep slopes and revegetation will be slow on EG4.

EG is moderately important to wildlife. The mosaic of habitats supports a variety of small mammals. But deep snow restricts use by ungulates and carnivores in winter.

EN - ENDLESS CHAIN ECOSECTION

The Endless Chain (EN) Ecosection concept incorporates colluvial landforms comprised of noncalcareous, coarse textured colluvium (Colluvium A) dominated by Upper Subalpine vegetation. A soil pattern in which Dystric Brunisols are dominant and Regosols subdominant characterizes EN soils. Only one Ecosite (EN3, Table 99) was recognized. Six EN3 tracts were mapped in two areas: on the mountain slopes above Vermilion Pass and on the walls of East Verdant Creek valley. Three are extensions of EN3 tracts in BNP. Fig. 21 illustrates topographic relationships among EN3 and other Ecosites associated with Gog Group quartzitic bedrock.

GEOMORPHOLOGY

EN is geomorphically characterized by colluvial landforms composed of Colluvium A (noncalcareous, coarse textured). In EN3, colluvium occurs as discontinuous blankets and veneers overlying steeply but irregularly sloping (step and riser) bedrock. The overall topography, (Fig. 21) is steep and relatively straight, with inclined slopes of shallow colluvium disrupted by exposed bedrock. The irregular topography of an EN3F tract in East Verdant Creek valley is probably due to partial slope failure, including bedrock and overburden. Slope range is 45 to >100%, although slopes <55% are rare. The underlying and exposed bedrock is mainly Gog Group quartzite.

Colluvial activity varies in kind and intensity across EN3 landscape. Snow avalanching and related processes, including erosion by intermittent streams, affect ≤20% of EN3 tracts because they are confined to couloirs. Avalanching is more extensive (≤50%) on EN3A tracts. Other forms of colluvial activity include shallow colluviation, soil creep, sheet erosion, and rock fall from bedrock escarpments. Thus, site stability in EN3 varies from stable (well vegetated with pedogenic soil development) to very active, often rubbly sites in and below couloirs and below rock walls. Thin, discontinuous veneers of Eolian material B (altered, medium textured) occur sporadically on the most stable sites. However, erosional and colluvial processes have removed or incorporated most of the eolian material.

SOILS

EN3 soils are rapidly to well drained and distributed in a pattern reflecting kind and intensity of colluviation, including avalanching and related processes, and the age of more stable sites. Dystric Brunisols dominate and are associated with sites stable enough for B horizons to develop. Most B horizons are Bm but occasionally thin Bf and Bhf horizons also occur. Strong weathering in the presence of Eolian material B at the oldest, most stable sites occasionally produces Orthic Humo-Ferric Podzols. Ae horizons also usually develop at more stable sites and the dominant Eluviated Dystric Brunisols, such as the pedon in Table D13, often display the development and deep weathering associated with noncalcareous, coarse textured parent materials. The pedon is from an EN3 tract near Cirque Lake in BNP but is representative of well developed EN3 soils in KNP. Orthic Dystric Brunisols are subdominant and occur where low intensity colluvial or erosional processes have inhibited the development of Ae horizons.

Table 99. Definitive features of Endless Chain (EN) Ecosites.

Ecosite	Landform	Soils	Vegetation
EN3	Colluvium A; blanket & veneer over inclined bedrock > exposed bedrock	Eluviated Dystric Brunisol > Orthic Dystric Brunisol, Orthic Regosol	mixed coniferous open forest (O4) > subalpine larch open forest (O13)

The other subdominant soils, Orthic Regosols, occur at sites that are or have recently been intensely active so that B horizon development has been inhibited. These soils may have thin Ah horizons or no A horizons and are prevalent in and below couloirs and below prominent bedrock escarpments.

Since colluvial materials are generally shallow, lithic phases are important. On some tracts, lithic phase soils may be more abundant than the deeper counterparts. Nonsoil (<10 cm of unconsolidated material over bedrock), associated with exposed bedrock, mav constitute 20 to 50% of EN3 tracts.

VEGETATION

EN3 is characterized by a v.t. pattern in which Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4) is dominant and subalpine larch-subalpine fir/heather (O13) is subdominant. Intergrades also occur. O4 is prevalent on subxeric, exposed sites, particularly on southerly aspects, and at lower elevations within the Upper Subalpine. O13 is most common on mesic sites and at higher elevations (>2100 m). Engelmann spruce-subalpine fir/heather (O10) occurs occasionally as an accessory v.t. A variety of low shrub and shrub v.t.s, such as subalpine fir-willow (S2) on avalanched portions, may also occur in minor amounts. Unvegetated or sparsely vegetated terrain is associated with active erosion or colluviation, such as frequently avalanched couloirs, and with some bedrock exposures. Such localities may constitute 20 to 50% of EN3 tracts. The EN3AB tract above Vermilion Pass is dominated by a mosaic of avalanche v.t.s and vegetation at an early stage of post-fire succession, with the standing snags of some localities indicating a pre-fire, open forest vegetation.

WILDLIFE

EN3 Wildlife Features

Ungulates: Few EN3 tracts occur in KNP and they are restricted to the eastern Main Ranges adjacent the KNP-BNP boundary. Although no plots were located in EN3, it is likely that it is of moderate importance, as in BNP (Holroyd and Van Tighem 1983).
Carnivores: EN3 is expected to be of low importance, as in BNP.
Small Mammals: Associations 1 and 5.
Few species occur here at low densities.
Breeding Birds: Community 7.
A low density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Townsend's Solitaire and Rosy Finch.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The EN Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and applied to identical landscape (0.2%) in KNP. Likewise, EN3 (0.2%) was extended, with minor modification to the vegetation component, to KNP. Two other EN Ecosites used in BNP and JNP,

Table 100. Wildlife features of EN Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
EN3	medium	mule deer goat	low		low	hare	low

dominated by spruce-fir closed to open forest (EN1) and by avalanche v.t.s (EN2), were not used because such landscapes in KNP were not extensive or were too small to map.

EN is the Upper Subalpine counterpart of the Alpine Tekarra (TK) Ecosection. Wildflower 3 (WF3) and Whitehorn 4 (WH4) resemble EN3. WF3, however, occurs on calcareous, medium textured colluvium (Colluvium C) and limestone bedrock and is characterized by more alkaline, often calcareous soils including Eutric Brunisols and Regosols. WH4 occurs on non- to weakly calcareous, medium textured colluvial material (Colluvium B) and slaty bedrock.

Use is limited by steepness and colluviation, stony surfaces, shallow soils, outcrops, and local snow avalanching. Removal of vegetation may increase erosion.

FR - FIRESIDE ECOSECTION

The Fireside (FR) Ecosection concept comprises: Montane forest vegetation, fan and apron landforms of calcareous fluvial material, and well to moderately well drained Eutric Brunisols. Two FR Ecosites (FR1 and FR3, Table 101) were differentiated primarily by lodgepole pine forest *vs.* white spruce forest. Both Ecosites occur on bottom- and benchland positions, mainly in the Kootenay, Simpson and lower Vermilion river valleys. Fig. 18 illustrates topographic relationships among FR3 and some other Ecosites.

GEOMORPHOLOGY

Fluvial material B (calcareous, coarse-stratified) is the main constituent of FR landforms. However, several gently sloping tracts have finer textured, weakly stratified, surficial sediments much like Fluviolacustrine material B (calcareous, fine-stratified) or, less often, Fluviolacustrine material A (altered, fine-stratified). These fine textured sediments occasionally are >1 m thick and sometimes are interbedded with the coarser Fluvial material B, especially on level landforms. The fine textures are probably generated by a combination of low energy fluvial or slope wash deposition plus the abundance of fine grained, argillaceous materials in surrounding landforms. Both the fine and coarse textured, stratified sediments are partially sorted which indicates deposition by flowing water. Some layers in lower control sections and below exhibit a poorly sorted, diamicton indicative of mudflow deposition, thought to be important in fan and apron construction. Thin veneers of Eolian material B (altered, medium textured) occur sporadically but are often difficult to distinguish from fluvial layers.

Fans and aprons with straight to concave slopes characterize the landform surface expression but some FR tracts include level and subtly terraced landforms. Also included are fluvial blankets overlying glaciofluvial and glacial landforms. Most tracts have simple slopes of 0 to 15%, less often 15 to 30%. Slope continuity is often subtly broken by abandoned and active stream channels (Eroded modifier, C.S.S.C. 1978a), including narrow, elevated ridges along the banks.

Table 101. Definitive features of Fireside (FR) Ecosites.

Eco-site	Landform	Soils	Vegetation
FR1	Fluvial material B; fan & apron	Orthic Eutric Brunisol > Eluviated Eutric Brunisol	lodgepole pine forest (C11, C38)
FR3	Fluvial material B; fan & apron	Orthic Eutric Brunisol > Eluviated Eutric Brunisol	white spruce forest (C37), mixedwood (C44)

SOILS

FR soils are typically well to moderately well drained, with pedogenic horizons indicating weathering in comparatively old, stable, landform surfaces. The characteristic soils are weakly to moderately developed Eutric Brunisols that reflect the calcareous parent materials and Montane environment. Occasionally, the Eutric Brunisols have luvisol-like Bm or BC horizons, (Table D14, Plate 26) but Luvisolics rarely occur. The BC horizon of the described pedon, from an FR1 tract near Kootenay Crossing, has more clay than adjacent horizons but the poor structure and lack of clay films differentiate it from Luvisolic Bt horizons in surrounding glacial landscapes.

Ae horizons are more often absent (Orthic Eutric Brunisol) than present (Eluviated Eutric Brunisol) at the mineral surface. However, Eluviated Eutric Brunisols tend to be more abundant on FR3 than FR1. Accessory soils include Orthic and Cumulic Regosols. These are restricted to narrow strips along stream channels and may be eroded or flooded during spring run-off and periods of high precipitation. Gleyed Eutric Brunisols occur occasionally in imperfectly drained, level to slightly depressed sites where seasonally high water tables affect control sections.

VEGETATION

FR1 is characterized by lodgepole pine forest with lodgepole pine/feathermoss (C11) and lodgepole pine/buffaloberry/pine grass (C38) as the dominant v.t.s. Lodgepole pine/dwarf bilberry (C9) and lodgepole pine/buffaloberry/twinflower (C19) occur often but not extensively. Lodgepole pine/buffaloberry/bunchberry (C39) occurs occasionally. Many C11 stands are young and even-aged with dense canopies. FR1 occurs on all aspects but most extensively on warmer, dry southerly aspects.

FR3 is characterized by white spruce forests. The main v.t.s are white spruce/buffaloberry/feathermoss (C37) and spruce-aspen-lodgepole pine-(paper birch)/buffaloberry/pine grass (C44) (Plate 27). White spruce-Douglas fir/feathermoss (C5) occurs often but is of limited areal extent. White spruce-western larch-Douglas fir/bunchberry (C45) occurs occasionally and is most abundant south of Swede Creek. Engelmann spruce-subalpine fir/feathermoss (C13) also occurs in minor amounts but the Engelmann spruce-subalpine fir canopy is often replaced by white spruce or spruce hybrids. An FR3 tract at McLeod Meadows with white spruce dominance has an unusually open, ragged canopy, possibly the result of logging. FR3 occurs on all aspects but is more extensive on moist northerly aspects.

WILDLIFE

Table 102. Wildlife features of FR Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
FR1	medium	elk deer	high	coyote cougar	medium	hare beaver	medium
FR3	high	elk deer	high	coyote cougar	medium	red-b. vole beaver	high

FR1 Wildlife Features

Ungulates: FR1 is highly important to elk in winter and moderately important to white-tailed deer in summer and fall. It is highly important to mule deer in winter along Sinclair and Redstreak creeks. Use is highest where associated with AT1, FR3 and AT4 Ecosites and Highway 93 grasslands. Overall, browse use is low; heaviest used species include willow (*Salix scouleriana, Salix glauca*), aspen (*Populus tremuloides*) and saskatoon (*Amelanchier alnifolia*).

Carnivores: FR1 is highly important, particularly to coyotes and cougars during winter. Coyote use is highest where FR1 is associated with Highway 93. Wolves made moderate use of FR1 during winter 1982-83.

Small Mammals: Associations 2 and 3.
FR1 has a moderate number of species at moderate densities. Snowshoe hares occur at very high densities in C11 and C19 v.t.s. FR1 is also important to beavers.

Breeding Birds: Communities 1, 5 and 19.
A medium density of birds was recorded. Species diversity is high. Based on density indices derived from circular census plots, this Ecosite is highly important to Olive-sided Flycatcher.

FR3 Wildlife Features

Ungulates: FR3 is highly important, particularly to elk in winter and white-tailed deer in summer and fall. Use is particularly high where associated with other fluvial landforms (AT4, HD3, HD6) and Highway 93. Browse use is high. Heaviest use is of willow (*Salix* spp.) and saskatoon (*Amelanchier alnifolia*).

Carnivores: High prey availability and favorable winter snow conditions make FR3 highly important, particularly in winter. Coyotes make heavy use of FR3 year round where it is associated with Highway 93. Wolves made frequent use of similar areas during winter 1982-83.

Small Mammals: Associations 2 and 3.
A moderate number of species occurs here in moderate densities. FR3 is most important to red-backed voles and beavers.

Breeding Birds: Communities 1 and 19.
A high density of birds was recorded. Species diversity is high. Based on density indices derived from circular census plots, this Ecosite is highly important to Yellow-bellied Sapsucker, Tennessee Warbler, Swainson's Thrush, and Brown-headed Cowbird.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The FR Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and applied to similar landscape (2.9%) in KNP. Likewise, FR1 (1.0%) was extended, with minor modification to the vegetational component, to KNP. FR3 (1.8%) was added to accommodate fluvial landscape with Montane white spruce forests, an uncommon combination in BNP and JNP.

FR is the Montane counterpart of the Lower Subalpine Altrude (AL) Ecosection. Hillsdale 3 (HD3) resembles FR3 but occurs on more recent fluvial deposits where Regosolic soils are dominant. Vermilion Lakes 6 (VL6) sometimes may be similar to FR1 or FR3, but VL6 has wet soils and open forests indicating periodically high water tables.

FR tracts with gentle slopes generally have no landform, soil, or vegetational characteristics limiting to campground, trail, or related uses. Locally occurring coarse textures and high water tables may present problems for sewage disposal. But the gravelly coarse textured material is suitable aggregate for construction. Most tracts have streams that are suitable domestic water supplies. Exceptional floods and mudflows may occur, although soil development indicates stability.

Fluvial fans such as FR are key areas of ungulate use and have high breeding bird densities in mixedwood forests.

FV - FAIRVIEW ECOSECTION

The Fairview (FV) Ecosection concept incorporates: Lower Subalpine vegetation on colluvial landforms of non- to weakly calcareous, medium textured colluvium (Colluvium B). Dystric Brunisols are characteristic soils although Regosols are abundant in some FV landscapes. Four FV Ecosites (Table 103) differ in vegetation and soil patterns relative to kind, intensity and duration of colluvial processes. FV Ecosites were mapped on valley walls in the western Main Ranges. Figs. 20 and 23 illustrate topographic relationships among the FV Ecosites and others associated with Chancellor Formation bedrock.

Fig. 20. Landscape schematic of topographic relationships among FV and WH Ecosites.

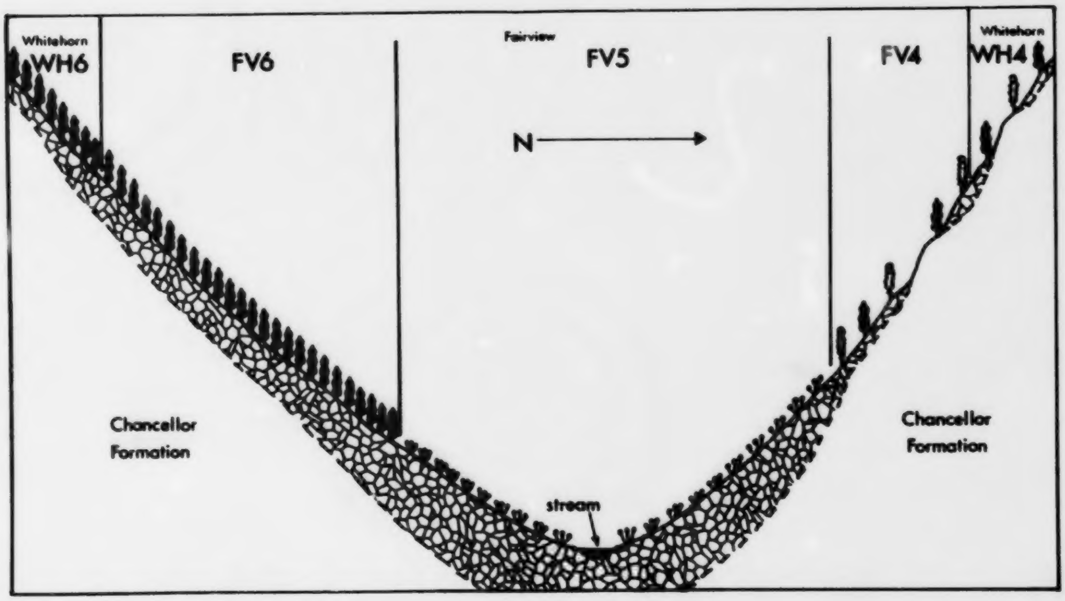


Table 103. Definitive features of Fairview (FV) Ecosites.

Ecosite	Landform	Soils	Vegetation
FV3	Colluvium B; veneer & blanket over inclined bedrock	Eluviated Dystric Brunisol > Orthic Dystric Brunisol, Orthic Eutric Brunisol	lodgepole pine forest (C20 > C10)
FV4	Colluvium B; veneer over inclined bedrock + exposed bedrock	Lithic phases: Orthic Dystric Brunisol > Orthic Regosol, Orthic Eutric Brunisol; + nonsoil	mixed coniferous open forest (O4)
FV5	Colluvium B; blanket over inclined bedrock, apron; avalanched	Orthic Dystric Brunisol, Cumulic Humic Regosol, Cumulic Regosol > Orthic Eutric Brunisol, Orthic Humo-Ferric Podzol	Avalanche complex 3 > Engelmann spruce-subalpine fir forest (C14)
FV6	Colluvium B; veneer & blanket over inclined bedrock	Eluviated Dystric Brunisol > Orthic Dystric Brunisol, Orthic Eutric Brunisol	Engelmann spruce-subalpine fir forest (C14)

GEOMORPHOLOGY

FV is geomorphically characterized by colluvial landforms comprised of Colluvium B (non- to weakly calcareous, medium textured). Most landscape mapped as FV is located in the western Main Ranges, east of the Vermilion/Mitchell ranges, where the colluvium is derived form Chancellor Formation slate. Several tracts occur west of the Vermilion/Mitchell Ranges on McKay Group bedrock. Whether McKay Group or Chancellor Formation, the slaty bedrock is recessive and the mountain topography is subdued, albeit steep. The top part of the recessive bedrock is occasionally weathered, remaining *in situ* as a veneer of Residuum A (non- to weakly calcareous, medium textured) that is transitional between the colluvium above and consolidated bedrock below. Residuum is occasionally exposed on gentle slopes. Colluvium C (calcareous, medium textured) occurs sporadically and is associated with localized limestone layers within the slaty strata. Discrete veneers of Eolian material B (altered, medium textured) are rare in FV. If present, eolian material is usually mixed with colluvium in upper soil horizons.

The colluvium occurs most often as veneers and blankets that reflect steeply inclined bedrock on valley walls. The Ecosite Modifier X, meaning lithic phase soils are dominant, can be applied to any FV Ecosite (*e.g.* FV6X above the Simpson River) except FV4 and indicates that colluvial veneer is the dominant landform. Discontinuous colluvial veneer with lithic phase soils and exposed bedrock are the norm in FV4. Comparatively deep colluvial aprons occur in some valleys where they form the lower slopes between valley floor and wall. They are usually constructed by snow avalanching and rockfall below very steep rocky slopes. Numerous shallow, poorly entrenched couloirs channel intermittent streams and mudflows onto the aprons. Thus, the apron landforms are often a mixture of intercalated colluvial, fluvial, and mudflow deposits.

Slopes are usually long and straight (simple) with a mapped range of 45 to >100%, although slopes <55% are not extensive. FV4 typically has the steepest (rarely <60%), most irregular slopes, although cliff and bench topography is not as well expressed on the recessive bedrock as on limestone (SB4 Ecosite). Except for bedrock prominences on some FV4 tracts, exposed bedrock normally blends into the overall slope and massive, precipitous cliffs are uncommon. Tracts with the modifier

F (*e.g.* FV6F east of Limestone Peak) generally have a subdued, hummocky to ridged, bench-like topography superimposed on an inclined slope. This subtly irregular topography is produced by partial failure within the bedrock. Tension cracks and short slip scars are often evident, particularly where the overburden is shallow.

Present colluvial activity is highly variable both within and among FV Ecosites. Landform construction has virtually ceased where vegetation is relatively well established, uniform, and complete as in FV3 and FV6. Here the presently or recently operating geomorphic processes are low intensity, slow ones that modify near-surface materials. These processes include uprooting of trees, soil creep, and solifluction and are manifest by mixed or disrupted upper sola horizons. Colluvial activity is more diverse with variation in kind and intensity on terrain characterized by snow avalanching (FV5) and rugged rocky slopes (FV4). Depositional and erosional processes here include rockfall, avalanching, fluvial and mudflow activity, slope wash, and soil creep. Modifying processes include uprooting of trees, soil creep, and solifluction. Thus, sites vary from those that are comparatively stable (well vegetated with pedogenic soil development) to very active, often rubbly, unvegetated sites.

While snow avalanching is widespread (>50%) and characteristic of FV5, it may affect up to 20% of other FV tracts. For example, channeled paths are a common feature of low areal extent on FV4 because they are confined to some of its poorly incised couloirs. However, avalanching is more extensive (20-50%) on tracts mapped as FV4A. Forested tracts with the symbol modifier A may also have 20 to 50% of their area affected by avalanching (*e.g.* FV6A).

SOILS

The soils of FV are rapidly to moderately well drained. Their distribution and development reflect variations in kind, intensity, and duration of disturbance (geomorphic) processes. Brunisolic soils are associated with sites where geomorphic activity is of low intensity or has ceased, provided there has been sufficient time for B horizon development. Dystric Brunisols characterize FV and are the dominant or codominant soils of each Ecosite (Table 103). These soils commonly have moderately to well developed Bm horizons and strongly to extremely acidic (pH <5.5) lower sola. They may have either weakly to moderately developed Ae horizons (Eluviated Dystric Brunisols), most abundant under closed forest vegetation, or minimal to no Ae horizon development (Orthic Dystric Brunisols), which infers some low intensity surface activity. The sampled pedon (Table D16, Plate 28), from the FV6A tract above Numa Creek, illustrates soil development in low lime colluvium on very steep, stable slopes with closed forest. The site has been stable for a long time.

Orthic Eutric Brunisols, among the subdominant soils of all four FV Ecosites, are similar to Orthic Dystric Brunisols but have medium acid to neutral (pH ≥5.5) lower sola. They are developed in weakly calcareous colluvium where weathering has been insufficient to acidify their sola, likely because there is still minor activity or stability has been of short duration. Eluviated Eutric Brunisols, similar to Eluviated Dystric Brunisols except in pH characteristics, also occur occasionally (accessory soils) in FV3 and FV6.

Orthic Humo-Ferric Podzols, another group closely related to Orthic and Eluviated Dystric Brunisols, occur occasionally on FV. They are accessory soils in FV6 and represent the strongest development in the most stable sites, usually occuring where Eolian material B is a significant constituent of upper sola. Orthic Humo-Ferric Podzols are among the subdominant soils of FV5 and occur where humus and mineral material conducive to their development were mechanically incorporated as part of their middle sola. Subsequent stabilization, even though avalanching still affects the vegetation cover, has allowed normal pedogenic weathering processes to operate. The products include some unusual Podzolic soils like the base-rich sampled pedon (Table D15, Plate 29), from an FV5 tract near the Vermilion River - Numa Creek confluence. Orthic Ferro-Humic Podzols may also occur occasionally in the complex geomorphic environment of avalanche slopes.

Brunisolic and Podzolic soils on avalanche paths often have thin Ah horizons, developed under organic horizons produced by the shrub and herb vegetation. Closely related Orthic Sombric and Melanic

Brunisols and Sombric Humo-Ferric Podzols, have thick (>10 cm) Ah horizons likely produced by mechanical incorporation of humus into the uppermost mineral materials.

In contrast to the comparatively stable Brunisolic and Podzolic soils, Regosolic soils occur at sites that are or have recently been intensely active so that B horizon development has been inhibited. They are codominant on FV5, one of the subdominant soil groups on FV4, and occur in minor amounts on other FV Ecosites. Various Regosolic groups occur, particularly on avalanched terrain. Orthic Regosols, with low but relatively uniform organic matter contents throughout their profiles, are associated with intense erosion and frequent, humus-poor, mineral deposition. Others have mechanically mixed and buried, humus-rich layers within the profiles (Cumulic Regosols), sometimes with thick (>10 cm), mechanically mixed Ah horizons at the mineral surface (Cumulic Humic Regosols). The latter two groups occur only on avalanche paths and are most abundant on colluvial aprons where deposition is greatest and tends to be episodic. The variety of Brunisolic, Regosolic and Podzolic soils on FV5 demonstrates the diverse and complex interactions of geomorphic activity and pedogenic weathering on avalanched terrain, likely the most complex landscape in KNP.

The colluvium is often a shallow veneer, especially on steep slopes, and while lithic phase soils are common in any FV Ecosite, they are characteristic of FV4. However, nonsoil areas are also extensive (up to 80%) on FV4, occurring as exposed bedrock or where there is <10 cm of overburden. Turbic soil phases may also occur on any FV Ecosite but are more common as accessory features on FV3 and FV6. Manifestations include mixed, contorted, displaced or disrupted horizons produced by solifluction, soil creep and tree throw.

VEGETATION

The v.t.s that typify each FV Ecosite (Table 103) reflect differences in fire history and geomorphic activity. Closed forests develop on stable slopes. FV6 is characterized by Engelmann spruce-subalpine fir forest with Engelmann spruce-subalpine fir/false azalea (C14) the predominant v.t. Engelmann spruce-subalpine fir/feathermoss (C13), Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) and Engelmann spruce-subalpine fir/green alder (C25) are accessory v.t.s. C13 and C25 tend to occur at low elevations transitional to Montane and C13 favors drier sites with southerly aspect. C21 occurs at higher elevations transitional to Upper Subalpine. In contrast, FV3 has lodgepole pine forest and a v.t. pattern with lodgepole pine/false azalea/grouseberry (C20) more abundant than lodgepole pine/green alder/feathermoss (C10). The latter commonly occurs as small patches and strips surrounded by C20.

The steepness and ruggedness of FV4 terrain, occurring on all aspects and at all elevations within the Lower Subalpine, is reflected in the vegetation. This Ecosite is characterized by the Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4) v.t. A variety of low shrub and shrub v.t.s, such as subalpine fir-willow (S2) and green alder/fern (S13) on avalanched portions, may also occur in minor amounts. Unvegetated or sparsely vegetated terrain is associated with very active erosion or colluviation, such as frequently avalanched couloirs, and with large, very steep, bedrock exposures. Such localities, interspersed amongst vegetated areas, may constitute up to 50% of some FV4 tracts.

The geomorphic-soil diversity of snow avalanched terrain, occurring on all aspects and at all elevations within the Lower Subalpine, also applies to vegetation. Avalanched segments dominate FV5 and are characterized by a heterogeneous complex of v.t.s termed ***Avalanche complex 3***. Green alder/fern (S13) is the most abundant v.t. (Plate 30) but subalpine fir-willow (S2), fireweed-meadow rue (H22) plus intergrades and other heterogeneous assemblages occur frequently as small patches. S2 occurs mostly at high elevations near the Upper Subalpine and meadow-like patches of H22 are conspicuous on the runout zones of many avalanche paths. Forested sites, unaffected by avalanching, usually constitute significantly <50% of FV5. They fringe avalanche runout zones and form strips between avalanche paths. The most common forest v.t. is Engelmann spruce-subalpine fir/false azalea (C14) although Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4) also occurs occasionally as an accessory v.t. Lodgepole pine forest, such as lodgepole pine/false azalea/grouseberry (C20), occurs only sporadically on FV5. Avalanche complex 3 vegetation also occurs in minor amounts on FV3, FV4, and FV6 but occupies 20 to 50% of tracts with the modifier A (*e.g.* FV6A in Floe Creek valley).

WILDLIFE

FV3 Wildlife Features

Ungulates: FV3 is generally of low importance. Elk make moderate to heavy use of FV3 in summer, especially where avalanched. Snow depths >1.0 m prevent much winter use by ungulates.

Carnivores: FV3 is of moderate importance to most carnivores and of high importance to cougars in summer.

Small Mammals: Association 3.
FV3 is moderately important, particularly to snowshoe hares and red-backed voles which occur at high densities.

Breeding Birds: Communities 1 and 19.
A high density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Yellow-bellied Sapsucker, Tennessee Warbler, Swainson's Thrush, and Brown-headed Cowbird.

FV4 Wildlife Features

Ungulates: FV4 is of moderate importance, due to moderate use by elk in summer and moderate to high use by mountain goats in summer and fall. The greatest use of FV4 by goats is on Mount Wardle, however it may also be important in other locations especially where rocky escape terrain is available.

Carnivores: FV4 is of low importance overall. It may be of moderate importance to cougars in summer and fall, particularly on Mount Wardle where goat use is high.

Small Mammals: Association 1.
FV4 supports a large number of species at moderate densities. Species occurring in high numbers include pika, golden-mantled ground squirrel and deer mouse.

Breeding Birds: Community 7.
A low density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Yellow-rumped Warbler, Ruby-crowned Kinglet, Mountain Chickadee, and Gray Jay.

FV5 Wildlife Features

Ungulates: This highly avalanched Ecosite is of high importance to elk in summer and fall, and moderately important to moose in winter. One tract sampled above upper Verdant Creek had very high browse use, predominantly on willow (*Salix glauca*) and currant (*Ribes* spp.).

Carnivores: FV5 is of moderate importance overall, and of high importance to cougars and wolverines.

Small Mammals: Associations 8, 2 and 1.
This avalanche dominated Ecosite supports a high diversity of species at low to moderate densities. The highest densities encountered of long-tailed voles and western jumping mice occurred here. FV5 is also important to meadow voles and deer mice.

Breeding Birds: Communities 7, 8 and 12.
A medium density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Wilson's Warbler, White-crowned Sparrow, MacGillivray's Warbler, and Fox Sparrow.

Table 104. Wildlife features of FV Ecosites.

Ecosite	UNGULATES Overall rank	 Important species	CARNIVORES Overall rank	 Important species	SMALL MAMMALS Overall rank	 Important species	BIRDS Overall rank
FV3	low	elk	high	cougar	medium	hare red-b. vole	medium
FV4	medium	elk goat	low		high	pika deer mouse	low
FV5	medium	elk moose	medium	wolverine cougar	medium	long-t. vole jumping-mouse deer mouse meadow vole	medium
FV6	low	moose	low		medium	porcupine red-b. vole long-t. vole	low

FV6 Wildlife Features

Ungulates: FV6 is of low importance. Avalanched tracts receive moderate use from elk and mule deer in summer and moose in winter. Snow depths >1.4 m seriously restrict winter use by ungulates.

Carnivores: FV6 is of low importance.

Small Mammals: Associations 2 and 3.

A moderate number of small mammals occurs here. Porcupines, red-backed voles and long-tailed voles occur at high densities.

Breeding Birds: Community 8.

A low density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Wilson's Warbler, MacGillivray's Warbler, Townsend's Warbler, Golden-crowned Kinglet and Tennessee Warbler.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The FV Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and modified to accommodate similar landscape (7.0%) in KNP. Modification was mainly to the genetic material component in that Colluvium A (noncalcareous, coarse textured) was deleted because it does not occur in FV terrain of KNP. Further, the Colluvium B concept was expanded to include weakly calcareous material derived from slaty bedrock. FV3 (1.2%), FV4 (0.6%), FV5 (1.0%) and FV6 (4.1%) were added to distinguish KNP landscape with subdominant Eutric Brunisols from BNP and JNP landscape where soils with pH $\geq$5.5 are uncommon. This distinction is linked to the random but common occurrence of low-lime colluvium in KNP FV Ecosites and to the variability in weathering, dependent upon relative duration and degree of site stability.

FV is the Lower Subalpine counterpart of the Upper Subalpine Whitehorn (WH) and the Alpine Redoubt (RD) Ecosections. The Sawback (SB) Ecosection resembles FV but occurs on calcareous colluvial materials (Colluvial materials C and D) derived from carbonate and calcareous clastic bedrock. Also, SB has more alkaline, often calcareous soils including Regosols and Eutric Brunisols.

Steepness and colluviation are major limitations. The Ecosites from most to least active are: FV5 (avalanched), FV4 (craggy), and the others (forested). Removal of vegetation may increase erosion. FV is important to wildlife mainly where avalanched, since deep snow limits winter use elsewhere.

HC - HECTOR ECOSECTION

The Hector (HC) Ecosection concept incorporates wetland soils and vegetation on fluvial landforms in the Lower Subalpine. The prevalent feature is wetness generated by high water tables and seepage, and it occurs on valley bottoms and gentle, lower slopes adjacent to streams in the Main Ranges. Only one HC Ecosite (HC1, Table 105) was recognized. The typical landscape position is illustrated in Fig. 22.

GEOMORPHOLOGY

Fluvial material B (calcareous, coarse-stratified) is the main constituent of HC1 landforms but Glaciofluvial material B (calcareous, coarse textured) also occurs in level landforms along major streams. Fine textured sediments, mainly Fluviolacustrine material B (calcareous, fine-stratified) also occur, most often as surface and subsurface layers interbedded with coarser materials on level landforms, or less often as weakly stratified, surficial sediment on fans and aprons. Fluviolacustrine deposition occurs in low energy fluvial environments of floodplain backwaters and gently sloping fringes of fans and aprons. Subsurface layers in fans and aprons include a poorly sorted, till-like material indicative of mudflow, thought to be an important constructional process. The mineral materials may be thinly mantled by peat, depending on the amount of mineral material accretion. This fen peat, rarely >1.2 m thick, is mainly moderately decomposed but fibric and humic layers and wood fragments also occur. Horizontal fen occurs where the peat is >40 cm thick due to cessation of mineral deposition and is an accessory landform.

HC1 occurs most often on level floodplain and subtly terraced terrain bordering major streams. Slopes are 0 to 5% although slopes >2% are rare. Two HC1 tracts are predominantly aprons and fans with slopes ≤15%. Tracts with complex slopes include both apron-fan and level landforms or have fluvial veneers and blankets overlying glacial deposits. Fans and aprons usually extend from lower valley wall to valley bottom. Slope continuity is often subtly broken by stream channels (Eroded modifier, C.S.S.C. 1978a), including narrow, elevated ridges along the banks. Channels are better expressed and more abundant on floodplains than on fans and aprons.

SOILS

The HC Ecosection is characterized by imperfectly to very poorly drained Regosolic, Gleysolic and Organic soils. HC1 is dominated by Rego Gleysols and Gleyed Cumulic Regosols with poor and imperfect drainage, respectively. Gleying is variable and depends on duration of saturation. Rego Gleysols are affected by longer saturation periods than Gleyed Cumulic Regosols. Both groups reflect the geomorphic environment in which recent deposition has precluded pedogenic horizonation. However, many profiles show *Cumulic* features (stratified mineral plus organic or organo-mineral layers) indicating that deposition is intermittent. Gleyed Regosols, with uniform colors and organic matter indicative of frequent deposition, also occur occasionally as accessory soils. Minor amounts of well to moderatly well drained soils, mainly Orthic and Cumulic Regosols, occur on small terraces elevated above present floodplains in a few HC1 tracts.

Not all HC1 soils are affected by recent deposition. Fen peat has accumulated in the absence of deposition on poorly to very poorly drained soils such as a peaty phase pedon (Table D17, Plate 31), sampled near the Ochre Beds southwest of Marble Canyon. Fen peat >40 cm thick and Organic soils, mainly Terric Mesisols, occur as accessory soils and are very poorly drained. A few imperfectly to poorly drained mineral soils escaped mineral deposition long enough for B horizons, mainly Bm or Bg, to develop. Thus, Gleyed Eutric Brunisols and Orthic Gleysols are also accessory soils. Gleyed Ferro-Humic Podzols and Gleyed Humo-Ferric Podzols, with podzolic Bhf and Bf horizons developed in silty veneers, also occur sporadically.

Table 105. Definitive features of Hector (HC) Ecosites.

Eco-site	Landform	Soils	Vegetation
HC1	Fluvial material B; level, apron & fan	Rego Gleysol, Gleyed Cumulic Regosol	wet Engelmann spruce-subalpine fir open forest (O6), wet spruce open forest (O11)

VEGETATION

HC1 is characterized by a variety of spruce and spruce-fir forest v.t.s. The main v.t.s are Engelmann spruce-subalpine fir/willow/ribbed bog moss (O6) and spruce/Labrador tea/brown moss (O11) which grade to white spruce-subalpine fir/bunchberry-horsetail (C41) and Engelmann spruce-subalpine fir/rock willow/bracted lousewort (O14). The latter two are accessory v.t.s occurring along channels and at high elevation, respectively. Forest continuity is broken by small patches of wet shrubby meadow, mainly dwarf birch-shrubby cinquefoil-willow/brown moss (S1), and sedge fen, mainly water sedge-beaked sedge (H11). Minor amounts of drier forest v.t.s such as Engelmann spruce-subalpine fir/feathermoss (C13), Engelmann spruce-subalpine fir/false azalea (C14) and white spruce/buffaloberry/feathermoss (C37) occur in a few HC1 tracts on small elevated terraces. Two HC1A tracts occur with 20 to 50% of the area modified by snow avalanching. Modification is mainly to vegetation and various herb and shrub v.t.s, including green alder/fern (S13) and unvegetated localities, occur on the avalanche paths.

WILDLIFE

HC1 Wildlife Features

Ungulates: HC1 is of high importance to moose year round and to elk in summer and fall. Use is highest by moose in C41 and S1 v.t.s, and by elk in O11, O14, S1 and H11 v.t.s.

Carnivores: HC1 is highly important, especially to coyotes and cougars in summer and weasels year round.

Small Mammals: Associations 4 and 3.
A moderate number of species occurs here at low to moderate densities. Meadow voles occur at high density.

Breeding Birds: Communities 6, 8, 12, 20 and 15.
A high density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Yellow-rumped Warbler, Tennessee Warbler, Spotted Sandpiper, Savannah Sparrow and American Robin.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The HC Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and applied to similar landscape (0.3%) in KNP. Likewise, HC1 (0.3%) was applied, with minor modification, to KNP. Two other HC Ecosites used in BNP and JNP are unmappable in KNP.

HC is the Lower Subalpine counterpart of the Montane Vermilion Lakes (VL) Ecosection. Consolation Valley 1 (CV1) resembles HC1 but has glacial landforms and wet soils with pedogenic rather than geomorphic horizons. Altrude 3 (AL3) and Pipestone 3 (PP3) sometimes resemble HC1 but they are characterized by drier soils and closed forests.

Table 106. Wildlife features of HC Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
HC1	high	moose elk	high	weasel coyote cougar	medium	meadow vole	high

Imperfect to poor drainage, due to flooding, seepage and high water tables, severely limits most uses. Also, fluvial deposition occurs locally. Major construction activities may alter hydrologic patterns. HC is highly important to wildlife, especially birds because of high habitat diversity. The willow (*Salix spp.) meadows are important winter habitat for White-tailed Ptarmigan and moose.*

HD - HILLSDALE ECOSECTION

The Hillsdale (HD) Ecosection concept includes: Montane vegetation; fan, apron, level, and terraced landforms composed of calcareous fluvial and glaciofluvial materials; and rapidly to moderately well drained Regosolic soils. The two HD Ecosites (Table 107) differ in vegetation, landform, and soils. HD3 occurs on the floors of several valleys south of Vermilion Crossing. HD6 is restricted to the floodplains and most recent terraces of the Kootenay and lower Vermilion rivers (Plate 32). Figs. 17 and 18 illustrate the topographic positions of HD3 and HD6, respectively. HD3 also often replaces Fireside 3 (FR3) in landscape schematics similar to that in Fig. 18.

GEOMORPHOLOGY

Fluvial material B (calcareous, coarse-stratified) is the main constituent of HD landforms. Glaciofluvial material B (calcareous, coarse textured) is also an important constituent of HD6 level and terraced landforms. Distinguishing the two genetic materials is often difficult because the influence of melting glacial ice is attenuated over the substantial distances between present glaciers and the HD6 tracts. Both likely occur and there is lateral and vertical gradation from glaciofluvial to fluvial deposits. Fine textured sediments, mainly Fluviolacustrine material B (calcareous, fine-stratified) also occur, most often as weakly stratified surficial sediments on fans and aprons; less often as layers interbedded with the fluvial and glaciofluvial deposits. Some geomorphic layers in fans and aprons exhibit a poorly sorted, till-like material indicative of mudflows, thought to be important in fan and apron construction.

HD3 landform surface expression ranges from fans and aprons with straight to concave slopes to level or subtly terraced terrain bordering major streams. Most tracts have simple slopes of 0 to 30%. Two tracts in the Western Ranges were mapped with complex slopes because they contain both the fan-apron and level landforms. HD6 is characterized by level floodplains and terraces although the risers are weakly expressed, being short and discontinuous, on the most recent terraces of the Vermilion and Kootenay rivers. Slopes are simple and 0 to 5%. Slope continuity on both Ecosites is often subtly broken by stream channels (Eroded modifier, C.S.S.C. 1978a), including narrow, elevated ridges along the banks. Channels are better expressed and more abundant on HD6 than on HD3.

Table 107. Definitive features of Hillsdale (HD) Ecosites.

Eco-site	Landform	Soils	Vegetation
HD3	Fluvial material B; fan, apron & level	Cumulic & Orthic Regosols	white spruce forest (C37), mixedwood (C44)
HD6	Fluvial material B & Glaciofluvial material B; level & terraced; eroded	Orthic Regosol > Gleyed Regosol	herb mat (H8)

SOILS

HD is characterized by rapidly to moderately well drained Regosolic with depositional layers rather than pedogenic horizons. These indicate current or recent fluvial deposition, which precludes pedogenic development. Cumulic Regosols, codominant in HD3 and accessory in HD6, show both pedogenic and physical incorporation of organic material either as buried Ah horizons or as organic matter that varies irregularly with depth, as in the HD3 pedon (Table D18, Plate 33) from the HD3 tract near McLeod Meadows. Such soils indicate that deposition was intermittent and that surficial organic layers formed during inactive periods. Orthic Regosols, codominant in HD3 and dominant in HD6, are more uniform in color and organic matter content, as in the pedon (Table D19, Plate 34) from the HD6 tract south of Vermilion Crossing, indicating more frequent and continuous geomorphic activity. Eutric Brunisols, either Orthic or Eluviated, occur in minor amounts on HD3 and are restricted to slightly elevated sites that have escaped fluvial activity for long periods.

HD3 soils are mainly well to moderately well drained. Drainage in HD6 is more variable, with rapid to imperfect being most common. This variability is due to variation in texture, stratification, and depth to fluctuating water table. Gleyed Regosols are subdominant on HD6, have mottles within 50 cm of the mineral surface and occur on imperfectly drained sites with high water tables. A few poorly drained sites have more strongly gleyed Rego Gleysols.

VEGETATION

HD3 and HD6 have different vegetation. HD3 has forests with white spruce dominant or codominant. The main v.t.s are white spruce/buffaloberry/feathermoss (C37) and spruce-aspen-lodgepole pine-(paper birch)/buffaloberry/pine grass (C44). White spruce-Douglas fir/feathermoss (C5) and western red cedar/oval leaf blueberry (C42) occur often but are of limited areal extent. C42 occurs as small groves interspersed with the spruce and mixedwood v.t.s along bottomlands of John McKay and Stoddart creeks. Other minor v.t.s are balsam poplar/horsetail (C28), also along John McKay Creek, and white spruce-subalpine fir/bunchberry-horsetail (C41).

HD6 is characterized by herb meadow, mainly the yellow dryad-willow herb (H8) v.t. which is dominated by yellow dryad (*Dryas drummondii*) and colonizes recently deposited sediments (Plate 35). Variations of H8 are common. The accessory v.t. junegrass-pasture sage-wild blue flax (H6) (Corns and Achuff 1982) occurs often on dry sites of limited areal extent. Moister vegetation on imperfectly to poorly drained sites resembles the sedge-saxifrage (H3, Corns and Achuff 1982) v.t. Several herb dominated stands also contain scattered (often <10% cover) low shrubs such as shrubby cinquefoil (*Potentilla fruticosa*) and juniper (*Juniperus communis*). Occasionally, shrubby vegetation resembling the willow/horsetail (S7, Corns and Achuff 1982) v.t. occurs on imperfectly to poorly drained sites. Bluebunch wheatgrass-hairy wild rye-showy aster (H19) occurs sporadically within HD6 on slightly elevated, very dry, old sites, *e.g.* gravel bars. Unvegetated terrain occurs on the youngest surfaces, which are usually flooded each year. Intergrades among the v.t.s are common, especially among H8, H3 and S7.

WILDLIFE

HD3 Wildlife Features

Ungulates: HD3 is of limited areal extent in KNP but is highly important year round. It is particularly important to white-tailed deer during summer and fall in the Kootenay Valley, mule deer in winter along John McKay and Sinclair creeks and moose in winter along Dolly Varden Creek and the Kootenay and lower Vermilion valleys. Browse use is moderate to high. Heaviest use is on willow (*Salix glauca*), red-osier dogwood (*Cornus stolonifera*), aspen (*Populus tremuloides*) and saskatoon (*Amelanchier alnifolia*).

Carnivores: High prey availability year round makes HD3 highly important to large carnivores, particularly coyotes and cougars.

Small Mammals: Associations 2 and 3.
A moderate number of species occurs here. High numbers of red-backed voles occur and HD3 is used by beavers.

Breeding Birds: Communities 1, 5 and 19.
A high density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Boreal Chickadee, Dark-eyed Junco, Gray Jay, Pine Siskin and Spruce Grouse.

HD6 Wildlife Features

Ungulates: HD6 is very highly important all year, but especially for elk in winter and spring and deer (primarily white-tailed deer) in summer and fall. The close association of these herb meadow - sparse shrub v.t.s with closed forest cover types (AT1, AT4, FR1, FR3), combined with low snow accumulation, provides excellent winter and early spring foraging habitat. Browse and forage use is very high on willow (*Salix glauca*), bluebunch wheatgrass (*Agropyron spicatum*), tufted hair grass (*Deschampsia caespitosa*), and timber oat grass (*Danthonia intermedia*).

Carnivores: As with HD3, high prey densities, year round and favorable winter snow conditions make HD6 highly important, especially for coyotes and cougars.

Small Mammals: Associations 4 and 1.
A low number of species occurs here at generally low densities. Only Columbian ground squirrels occur at high densities, however deer mice and meadow voles are relatively common but at low density.

Breeding Birds: Community 15.
A low density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Spotted Sandpiper.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The HD Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and applied to similar landscape (0.9%) in KNP. Likewise, HD3 (0.4%) was applied, with minor v.t. modifications, to KNP. However, HD6 (0.5%) was added in KNP for actively aggrading fluvial landscape with Montane herb meadow. Three other HD Ecosites used in BNP and JNP were not used in KNP since they are either not extensive or too small to map.

HD is the Montane counterpart of the Lower Subalpine Pipestone (PP) Ecosection. Fireside 3 (FR3) resembles HD3 but occurs on fluvial landforms with older, more stable surfaces as indicated by the dominance of Eutric Brunisols. Vermilion Lakes 2 (VL2) and 6 (VL6) sometimes are similar to HD6 and HD3, respectively. However, VL2 and VL6 are characterized by wet soils and by wet shrubby meadow and wet spruce open forest, respectively, which indicate that VL is much wetter than HD, probably because of periodically high water tables.

Table 108. Wildlife features of HD Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
HD5	high	moose deer	high	coyote cougar	low	red-b. vole beaver	high
HD6	very high	elk deer	high	coyote weasel cougar	low	Columbian gr. squirrel meadow vole beaver	low

Fluvial and mudflow deposition is sufficiently frequent to maintain the dominantly Regosolic soils and is a major factor in use planning. Unvegetated parts of HD6 are flooded annually. Locally occurring coarse textures and high water tables present problems for sewage disposal. The gravelly coarse textured material is suitable aggregate for construction. HD is very important to wildlife as critical range for elk and deer. High densities of birds, small mammals, and some carnivores also occur. Low snow accumulation and palatable forage contribute to its importance to ungulates.

HE - HEATHER ECOSECTION

The Heather (HE) Ecosection concept incorporates residual and bedrock landforms in the Alpine Ecoregion. Lithic phases of Brunisolic and Regosolic soils plus tundra, herb meadow and shrub-herb meadow vegetation characterize HE, but so do nonsoil and unvegetated localities. Only one HE Ecosite (HE2, Table 109) was differentiated. It was mapped on high elevation cirque floors and ridge crests in the Main Ranges.

GEOMORPHOLOGY

HE2 occurs dominantly as ridged bedrock outcrops with a sporadic mosaic of shallow, surficial veneers, collectively called ***regolith***. Bedrock controls many of the characteristics of HE2. Outcrop lithology is dominantly dense, massive, resistant limestone and dolomitic limestone of Cambrian age. Geologically associated units are the Cathedral and Eldon Formations (possibly some lower Chancellor Formation limestone in one cirque) in the eastern Main Ranges (six tracts) and the Ottertail Formation in the western Main Ranges (one tract). The dominantly ridged and, less often, hummocky topography generally parallels the gently dipping bedding planes of these eastern Main Ranges Formations. Less often, the surface cuts across steeply dipping bedding planes of varying lithology, as in the western Main Ranges tract. Slopes are 15 to 45%, although local slopes <15% and >45% also occur.

The dense, massive, carbonate bedrock is less deformed and jointed than most other rocks in the parks. Because widely spaced jointing is not conducive to physical weathering and chemical weathering is slow on carbonates, the bedrock is relatively unaffected and resistant. Thus, glacial scouring carried away less resistant overlying rock. Sporadic veneers of till and glacial striations are the main vestiges of glaciation and indicate that glaciers eroded very little of the resistant bedrock.

The subdominant regolith is a mosaic of eolian, morainal, fluvial, colluvial, and residual materials and most often occurs as a mixture of two or more materials. The vestigial glacial debris is Till C (calcareous, medium textured). Eolian material B (altered, medium textured) is another common

Table 109. Definitive features of Heather (HE) Ecosites.

Eco-site	Landform	Soils	Vegetation
HE2	Carbonate bedrock; ridged bedrock > regolithic veneer over ridged bedrock	Nonsoil > lithic phases: Orthic Melanic Brunisol, Orthic Humic Regosol	unvegetated > avens tundra (H1), moist herb meadow (H2), dwarf shrub-herb meadow (L7)

regolithic deposit but thin, intact veneers remain only where protected from erosion. Other local regolithic materials generated by frost shattering and subsequent gravity movement on steep slopes are, respectively, Residuum B (calcareous, medium textured) and Colluvium C (calcareous, medium textured). Mixing and redistribution of unconsolidated material by cryoturbation, solifluction, and fluvial activity is common. Fluvial and fluviolacustrine veneers of varying calcareousness and texture are common in inter-ridge and hummock depressions where the erosional products generated by slope wash and intermittent streams have accumulated. Fluvial processes have greatest impact during runoff in early summer. Regolith is absent, except in protected hollows and benches, on middle to upper slopes, and on bedrock ridge and hummock crests. From middle slopes to depressions, unconsolidated veneers become deeper and more abundant but rarely exceed 1 m in depth. Depressions often have very little exposed bedrock.

SOILS

The HE Ecosection is characterized by nonsoil (<10 cm of unconsolidated material over bedrock) and lithic phases of Brunisolic and Regosolic soils, usually with thick Ah horizons. HE2 is dominated by bedrock outcrop, thus a majority of any tract is nonsoil. Soils, mainly lithic phases of Orthic Melanic Brunisols and Orthic Humic Regosols, are associated with the subdominant regolith. Thick, dark colored Ah horizons high in organic matter are common to these soils. Occasionally, Orthic Eutric Brunisols and Orthic Regosols, both with Ah horizons <10 cm thick, occur. B horizons (Brunisolic soils) develop where the regolith is deepest and range from calcareous, weakly developed Bmk in highly calcareous materials to more strongly developed Bm, Bf or Bhf in silty, low lime deposits. A pedon (Table D20, Plate 36) from the HE2 tract near Chimney Peak is typical of HE2 Regosolic soils developed in shallow regolith. A lithic and turbic phase Orthic Melanic Brunisol, developed in deeper regolith, occurred at the toe of the slope <2 m below the sample site.

Most HE2 soils are rapidly to moderately well drained. A few depressions have impeded drainage and contain gleyed soils (imperfectly drained) and, occasionally, Rego Gleysols (poorly drained). Many HE2 soils contain contorted and mixed horizons generated by solifluction and cryoturbation and are turbic phase in addition to lithic phase.

VEGETATION

Vegetation is more extensive than soil areas, since it commonly develops on nonsoil as well as on soil areas. However, the majority of HE2 is unvegetated (vegetation with <20% cover) because of the dominance of bedrock outcrops (Plate 37). Saxicolous lichen (H12) occurs to a limited extent and is the initial colonizer on some bedrock localities. Where vegetation occurs on slopes and crests it is usually the mountain avens-snow willow-moss campion (H1) and arctic willow-cinquefoil (L7) v.t.s. Black alpine sedge-everlasting (H2) is also common but restricted to depressions with late snow melt. Imperfectly to poorly drained depressions may have H2, L7 or other wet Alpine v.t.s.

WILDLIFE

HE2 Wildlife Features

Ungulates: HE2 is sporadic and of limited areal extent in the eastern and western Main Ranges of KNP. It is generally of low importance except for mountain goats which use these areas year round.

Carnivores: HE2 is not important to carnivores.

Small Mammals: Association 1.

HE2 supports few species and only Columbian and golden-mantled ground squirrels are common on some tracts.

Breeding Birds: Community 18.

A low density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Water Pipit and Rosy Finch.

Table 110. Wildlife features of HE Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
HE2	low	goat	low		low	Columbian gr. squirrel golden-m. gr. squirrel	low

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The HE Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and applied to similar landscape (0.2%) in KNP. HE2 (0.2%) was likwise extended, with minor modification, to KNP. HE1, used in BNP and JNP for landscapes dominated by shallow residual materials on highly jointed recessive bedrock, was not used because similar landscapes in KNP were too small to map at 1:50,000. These small landscapes were included in tracts of Jonas 1 (JN1, *e.g.* on Monarch Ramparts), Reboubt 2 (RD2), Whitehorn 1 and 8 (WH1, WH8), and Colluvial Rubble (CR).

No other landscapes in KNP closely resemble HE2. Some PL4X tracts are similar but have more extensive, very shallow soils and scattered trees. Use is limited by outcrop, shallow soils, and irregular topography. Vegetation will recover slowly from disturbance.

IB - ISHBEL ECOSECTION

The Ishbel (IB) Ecosection concept incorporates landslide deposits dominated by Lower Subalpine vegetation. Only one IB Ecosite (IB4, Table 111) was differentiated and only one tract was mapped in KNP. It is a distinctive, prominent landscape on the valley floor where the Ochre Creek valley meets the Vermilion River valley.

Table 111. Definitive features of Ishbel (IB) Ecosites.

Eco-site	Landform	Soils	Vegetation
IB4	Landslide; hummocky	Orthic & Eluviated Dystric Brunisols	Engelmann spruce-subalpine fir forest (C14) > lodgepole pine forest (C20)

GEOMORPHOLOGY

The landslide deposit that forms the hummocky landform of IB4 likely originated from failure of Chancellor Formation, slaty bedrock high on the mountain slope above and southwest of the tract. The texture reflects the highly jointed, recessive character of the parent rock and its disintegration due to cataclysmic failure. Textures become coarser with depth and range from silt loam to loamy sand. This landslide material contains fewer large blocks and more fine earths than two limestone dominated landslides elsewhere in KNP but may become fragmental at about 2 m depth. The deposit is also non- to weakly calcareous, like the parent rock. Eolian material B (altered, medium textured) occurs occasionally, primarily as a mixture of eolian and landslide materials in upper sola. The mixing is due to disturbances such as tree throw.

The hummocky surface reflects genesis rather than bedrock control. Slopes are highly complex, of various length and 30 to 45%. The landslide is thought to rest on glacially formed benchland. If so, this landslide is postglacial.

SOILS

The IB Ecosection concept, as it applies to landslides in KNP, BNP and JNP, includes rapidly to well drained Regosolic, Brunisolic, and, occasionally, Podzolic soils plus minor amounts of nonsoil. This soil diversity is primarily a function of calcareous and fine earth content of the parent materials plus time over which pedogenic forces have been acting in the soils. The landslide material of IB4 in KNP contains appreciable fine earth, little or no lime and is sufficiently old that pedogenic horizonation has occurred. Bm horizons have developed and the sola are sufficiently acidified that Dystric Brunisols are dominant. Some pedons (Table D21, Plate 38) have pH values that place them near the taxonomic boundary with Eutric Brunisols. Occasionally, weathering is sufficient, particularly in the presence of Eolian material B, for Orthic Humo-Ferric Podzols to occur. Ae horizon development and thickness vary across the well drained landscape of IB4. Dystric Brunisols are divided, according to Ae horizon thickness, into Orthic (little or no Ae) and Eluviated ($\geq$2 cm Ae) subgroups, the co-dominant soils of IB4.

VEGETATION

The single IB4 tract is dominated by Engelmann spruce-subalpine fir forest, mainly the Engelmann spruce-subalpine fir/false azalea (C14) v.t. On some portions, particularly on the crest and northeast side, lodgepole pine is dominant or codominant, forming the lodgepole pine/false azalea/grouseberry (C20) v.t.

WILDLIFE

Table 112. Wildlife features of IB Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
IB4	low	elk	medium	marten weasel	low	red-b. vole deer mouse	medium

IB4 Wildlife Features

Ungulates: Only one tract of this landslide Ecosite occurs in KNP, near the mouth of Ochre Creek. It has high use by elk in summer probably due to its close association with HC1 and FV5 Ecosites.

Carnivores: IB4 is moderately important, especially to martens and weasels.

Small Mammals: Association 2.

A moderate number of species occurs here at low densities. Only red-backed voles and deer mice occur at high densities.

Breeding Birds: Communities 5 and 8.

A medium density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Golden-crowned Kinglet, Boreal Chickadee and Townsend's Warbler.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The IB Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and applied to similar landscape (0.1%) in KNP. However, IB4 (0.1%) was added to accommodate the specific soil and vegetational features in KNP. IB4 is a subset of the much broader IB3 concept of BNP and JNP, but with vegetation indicative of the moister climate west of the Continental Divide. No other landscapes in KNP resemble IB4. Use is limited by irregular topography and occasionally rubbly surfaces.

JN - JONAS ECOSECTION

The Jonas (JN) Ecosection concept incorporates: Alpine tundra vegetation; morainal landforms composed of non- to weakly calcareous, medium textured Till B; and well to moderately well drained, acidic soils, mostly Dystric Brunisols. One JN Ecosite (JN1, Table 113) was recognized. Ten tracts were mapped in high elevation cirques and cols and on ridge crests in the Main Ranges. Fig. 19 illustrates topographic relationships among JN1 and several other Ecosites associated with slaty bedrock.

GEOMORPHOLOGY

JN is geomorphically characterized by morainal landforms composed of Till B (non- to weakly calcareous, medium textured). Most JN1 tracts are in the western Main Ranges where the till is derived from Chancellor Formation slate. Till C (calcareous, medium textured) also occurs in minor amounts, particularly in JN1 tracts near the boundary between the western and eastern Main Ranges. One tract is on Monarch Ramparts in the eastern Main Ranges where Till B is derived from Miette Group slate. Whether Chancellor Formation or Miette Group, the slaty bedrock is recessive and the mountain topography is subdued. The top of this recessive bedrock is often weathered to a veneer of Residuum A (non- to weakly calcareous, medium textured) occurring between the till and

Table 113. Definitive features of Jonas (JN) Ecosites.

Ecosite	Landform	Soils	Vegetation
JN1	Till B; veneer over hummocky & ridged bedrock; soliflucted & cryoturbated	Turbic phases: Orthic Dystric Brunisol > Eluviated Dystric Brunisol, Orthic Sombric Brunisol, Orthic Humo-Ferric Podzol	heath tundra (L5)

consolidated bedrock. On a few ridge and hummock crests, the till is absent and the residuum is exposed to give small landscapes that resemble Heather 1 (HE1) mapped in BNP and JNP (Walker *et al.* 1982d).

The JN1F tract between Sharp and Helmet mountains on the Rockwall differs from other JN1 tracts and is unique in the Canadian Rocky Mountains. The till resembles a mixture of Tills A (noncalcareous, coarse textured) and B and is derived from resistant, medium to coarse grained, crystalline rocks of the Ice River alkaline complex. Textures are silt loam to loamy sand, coarse fragment content is moderate and the till rests on consolidated bedrock with little or no residuum between the two. Solifluction has severely affected the surface producing many lobes, some of which contain weakly expressed circles and nets produced by cryoturbation. Solifluction and cryoturbation have also disrupted and mixed soil horizons and partially sorted the materials to give a marbled appearance in any plane. Solifluction and, less frequently, cryoturbation are common processes on other JN1 tracts but the effects are less evident than on this JN1F tract.

Eolian material B (altered, medium textured) is a common constituent of JN1 landforms, occurring as a thin, discontinuous veneer mantling the till surface or as an eolian-till mixture generated by solifluction and cryoturbation. Occasionally, the eolian material has been eroded and redeposited as a medium textured fluvial veneer or fine textured fluviolacustrine veneer.

The morainal material commonly occurs as a veneer, less often a blanket, and the hummocky and ridged surface reflects the underlying bedrock. Slopes are complex and 15 to 45%, although slopes of 5 to 15% also occur.

SOILS

The soils of JN1 are well to moderately well drained and moderately to well developed. They reflect the acidic to neutral, medium textured parent material; humus accumulation in upper sola; the presence of Eolian material B; and the cool, moist Alpine environment. The various taxa (Table 113) have characteristics grouped around taxonomic boundaries. B horizon development is moderate to strong and ranges from Bm and Bf (Brunisolic soils) to podzolic Bf (Podzolic soils). Bf and podzolic Bf are more likely to develop where Eolian material B is a constituent of upper sola. Soils with Bhf and podzolic Bhf horizons (Orthic Ferro-Humic Podzols) also occur occasionally and the classification of JN1 Podzolic soils at the Great Group level is often tenuous when based on field characteristics alone.

An example pedon (Table D22, Plate 39) is from the JN1 tract near Floe Lake and has higher than normal coarse fragment content in lower horizons. A horizon development also varies and is a function of humus incorporation plus disruption or mixing. Thin Ah, Ahe, or mixed A+B or AB horizons occur most often. Stronger eluviation produces thin Ae horizons. Thick (≥10 cm) Ah horizons also occur occasionally where stability and humus incorporation are high or where organo-mineral materials have been physically thickened by solifluction. The Brunisolics are divided, according to A horizon characteristics, into Dystric (<10 cm Ah) or Sombric (≥10 cm Ah) great groups and Orthic (little or no Ae) or Eluviated (≥2 cm Ae) subgroups.

Most JN1 soils are solifluceted or cryoturbated and display mildly to moderately mixed or disrupted upper horizons. Thus, turbic phases are typical. Soils on the JN1F tract below Sharp Glacier are more severely affected than normal. In these, horizons are severely contorted and mixed, materials are partially sorted and the soils are regosol-like with minimal B horizons that are either remnant or reforming (Plate 40).

Important accessory soils are lithic phases and gleyed soils. The latter, mainly Gleyed Dystric Brunisols, occur in imperfectly drained depressions affected by seasonal seepage.

VEGETATION

JN1 is dominated by the heather-everlasting (L5) v.t. (Plate 41). Black alpine sedge-everlasting (H2) and everlasting-grouseberry (H17) are accessory v.t.s that occur frequently but not extensively. H2 occurs in late lying snow beds and in seepy depressions. H17 occurs with L5 on higher ground.

WILDLIFE

JN1 Wildlife Features

Ungulates: JN1 is moderately important to mountain goats in summer. It is suspected that moderate use is also made by elk in summer, however no evidence was found in 14 transects. High snow accumulations preclude winter use by ungulates.

Carnivores: JN1 is generally of low importance, however it is one of the few Ecosites where wolverine tracks were observed.

Small Mammals: Associations 5 and 1.
JN1 is of moderate importance. High numbers of pikas and hoary marmots occur and Columbian and golden-mantled ground squirrels are common on some tracts.

Breeding Birds: Communities 17 and 18.
A low density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Water Pipit.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The JN and JN1 concepts were developed in the BNP and JNP inventory (Walker *et al.* 1982d) and modified slightly to accommodate similar landscape (0.3%) in KNP. JN is the Alpine counterpart of the Upper Subalpine Egypt (EG) and the Lower Subalpine Cavell (CA) Ecosections. Eiffel 1 (EF1) resembles JN1 but occurs on coarser textured, noncalcareous, morainal material (Till A) derived from quartzitic bedrock.

Use is limited by solifluction, particularly on steep slopes or irregular topography. Locally, use may be affected by shallow soils and seepage. Removal of vegetation may result in erosion on steep slopes and revegetation will be slow.

JN is highly important for wolverines. High snow accumulations restrict winter use by ungulates. Heath meadows are highly important to small mammals and migrating and breeding passerines. Grizzly bear use is often high in summer and fall.

Table 114. Wildlife features of JN Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
JN1	low		low	wolverine	medium	pika marmot	low

LV - LARCH VALLEY ECOSECTION

The Larch Valley (LV) Ecosection concept includes: Upper Subalpine vegetation; morainal landforms of noncalcareous, coarse textured Till A; and well drained, acidic soils, mostly Dystric Brunisols. Vegetation ranges from Engelmann spruce-subalpine fir closed forest at low elevation to a pattern of heath tundra plus subalpine larch open forest at high elevation. Two LV Ecosites (LV2, LV3, Table 115) are differentiated mainly by contrasting vegetation patterns along with minor soil and landform differences. Fig. 21 illustrates topographic relationships among the LV Ecosites and others, notably the Alpine counterpart Eiffel (EF). LV occurs only in the eastern Main Ranges, primarily on valley walls and shoulders and less frequently on valley floors, in areas dominated by Gog Group quartzites. Ten LV tracts occur in: upper Tokumm Creek valley, above Vermilion Pass on a spur ridge of Storm Mountain, and in upper East Verdant Creek valley near Redearth Pass.

Fig. 21. Landscape schematic of topographic relationships among LV, EF and other Ecosites.

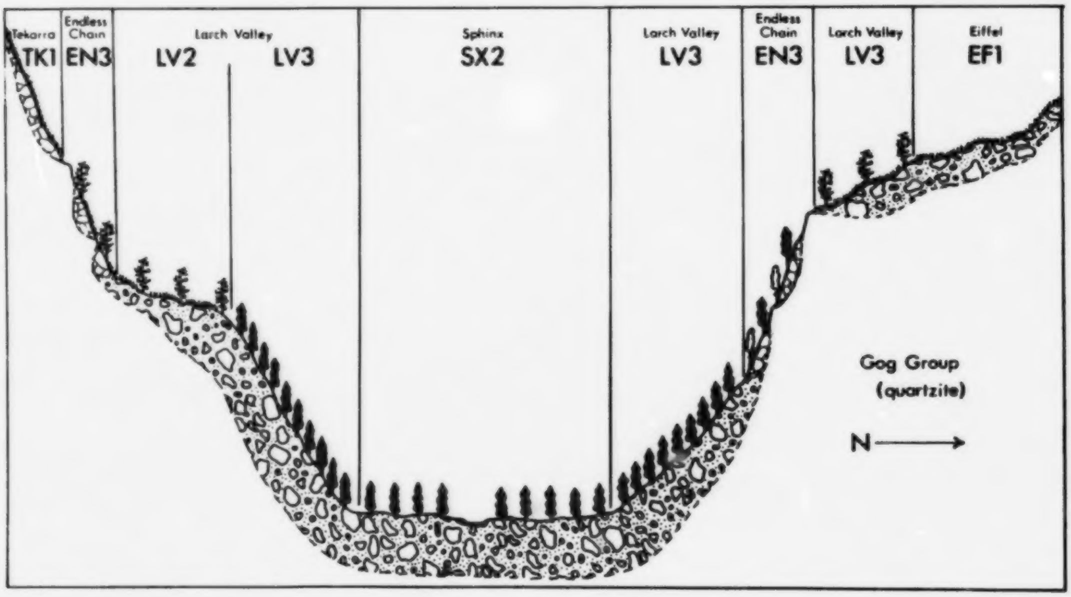


Table 115. Definitive features of Larch Valley (LV) Ecosites.

Eco-site	Landform	Soils	Vegetation
LV2	Till A; blanket & veneer over inclined, hummocky & ridged bedrock	Eluviated Dystric Brunisol > Orthic Dystric Brunisol, Orthic Humo-Ferric Podzol	heath tundra (L5) > subalpine larch open forest (O13)
LV3	Till A; blanket over inclined bedrock	Eluviated Dystric Brunisol > Orthic Humo-Ferric Podzol	Engelmann spruce-subalpine fir forest (C21 > C15)

GEOMORPHOLOGY

LV is geomorphically characterized by morainal landforms composed of Till A (noncalcareous, coarse textured). Colluvium, derived locally from till and exposed bedrock, occurs in minor amounts. Thin discontinuous veneers of Eolian material B (altered, medium textured) mantle the morainal material. The till occurs as veneer and blanket overlying inclined, hummocky, and ridged bedrock. Long, straight, inclined slopes of 30 to 70%, are associated with valley walls. Hummocky and ridged topography, with slopes 15 to 45%, is prevalent on valley floors and shoulders. The steep, irregular topography of LV3F in East Verdant Creek valley is probably due to bedrock failure. This tract includes minor amounts of exposed bedrock and small, sparsely vegetated, boulder-strewn patches. Many of the longer slopes in LV are dissected by gullies oriented perpendicular to the contour.

SOILS

Characteristic soils of the LV Ecosection are well drained and acidic. Dystric Brunisols are dominant and Humo-Ferric Podzols are subdominant. These are well developed soils and tend to be more deeply weathered and strongly eluviated than other Upper Subalpine soils on glacial drift, trends that reflect the noncalcareous, coarse textured parent material. Also, LV soils may be weakly cemented (duric tendency) in lower sola.

The various taxa (Table 115) have characteristics grouped around taxonomic boundaries. B horizon development is strong and ranges from Bm and Bf (Brunisolic) to podzolic Bf (Podzolic). Bf and podzolic Bf horizons are more likely to develop where Eolian material B is a significant constituent of upper sola. Soils with Bhf and podzolic Bhf (Orthic Ferro-Humic Podzols) also occur occasionally and the classification of LV2 Podzolics at the great group level is often tenuous when based on field characteristics alone. Eluvial (Ae) horizons are usually present and well developed at lower elevations, *i.e.* Eluviated Dystric Brunisols dominate LV3. At higher elevations (*i.e.* LV2), Ae horizon thickness is variable and Ae development may be masked by humus incorporation (Ah or Ahe horizons) under heath tundra. Orthic Dystric Brunisols, subdominant in LV2 and accessory soils in LV3, have little or no Ae horizon but may have a thin Ah horizon. Orthic Sombric Brunisols, with Ah horizons ≥10 cm thick, are accessory soils in LV2. Lithic phases occur occasionally, are associated with morainal veneers, and are more abundant in LV2 than LV3.

The pedon (Table D23, Plate 42) illustrating LV soils is from an LV1 tract on Panorama Ridge in BNP, about 10 km northeast of upper Tokumm Creek. Landscape similar to LV1 with extensive subalpine larch forest occurs in KNP, usually as narrow bands between LV3 and LV2, but is too small to map at 1:50,000. The pedon has a slightly disturbed upper solum and minor incorporation of underlying slaty material into its 2C horizon. Otherwise, the pedon is similar to LV soils in KNP.

VEGETATION

LV3 is characterized by Engelmann spruce-subalpine fir forest in which Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) is the dominant v.t. and Engelmann spruce-subalpine fir/grouseberry (C15) is subdominant. Subalpine larch-subalpine fir/grouseberry-everlasting (C23) and Engelmann spruce-subalpine fir/heather/feathermoss (C34) are accessory v.t.s that occur as small patches along the upper elevational limits of several LV3 tracts. An LV3A tract in Tokumm Creek has 20 to 50% of the area modified by snow avalanching. Modification is mainly to vegetation. Avalanche v.t.s such as subalpine fir-willow (S2) occur on avalanche paths and the paths are fringed by more than normal amounts of C23 or subalpine larch-subalpine fir/heather (O13).

LV2 is characterized by a vegetation pattern in which the heather-everlasting (L5) v.t. is more abundant than the subalpine larch-subalpine fir/heather (O13) v.t. (Plate 43). O13 normally occurs as single trees or islands of trees and includes krummholz on exposed sites and at the Upper Subalpine-Alpine boundary. Tree islands cover about 50% of the landscape at lowest elevations and 5% at the highest elevations. The Engelmann spruce-subalpine fir/heather (O10) v.t., characteristic of LV2 in JNP and northern BNP, occasionally replaces O13 in KNP.

WILDLIFE

LV2 Wildlife Features

Ungulates: LV2 is uncommon in KNP and is restricted to the eastern Main Ranges. Importance to ungulates is low. Moderate use is made by goats in summer and fall, while high snow accumulation prevents winter use.

Carnivores: LV2 is of low importance.

Small Mammals: Associations 5 and 3.
A large number of species occurs here at moderate to high densities. Hoary marmots and Columbian ground squirrels occur at high densities.

Breeding Birds: Communities 7 and 17.
A low density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Chipping Sparrow, Dark-eyed Junco and Fox Sparrow.

LV3 Wildlife Features

Ungulates: LV3 is more extensive than LV2, with a few tracts occurring in upper Prospector's Valley and East Verdant Creek. Data from BNP-JNP (Holroyd and Van Tighem 1983) suggest that LV3 is potentially of moderate to high importance to ungulates, particularly in summer. Limited sampling in KNP indicated no ungulate use, at least in upper Prospector's Valley. It is concluded that LV3 is of limited importance to ungulates in KNP.

Carnivores: LV3 is of moderate importance, primarily to martens.

Small Mammals: Association 3.
LV3 is of moderate importance. High densities of pikas, porcupines and red-backed voles occur here.

Breeding Birds: Community 8.
A medium density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Hermit Thrush and Varied Thrush.

Table 116. Wildlife features of LV Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
LV2	low		low		high	marmot Columbian gr. squirrel	low
LV3	low		medium	marten	medium	pika porcupine	medium

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The LV Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and applied to identical landscape (0.3%) in KNP. The soil and vegetation components of LV2 (0.1%) and LV3 (0.3%) were modified slightly. LV1, used to map BNP landscapes dominated by subalpine larch forest, was not used because similar landscape in KNP was too small to map.

The Egypt (EG) and Peyto Lake (PL) Ecosection resemble LV. However, EG occurs on finer textured till (Till B, non- to weakly calcareous, medium textured). PL occurs on calcareous till (Till C, calcareous, medium textured) and is dominated by Eutric Brunisols. LV is the Upper Subalpine counterpart of the Alpine Eiffel (EF) Ecosection.

Use is limited by coarse textures and steep slopes or irregular topography. Locally, use may be affected by stony surfaces and gullies. Removal of vegetation may result in erosion on steep slopes and revegetation will be slow in LV2. LV is moderately important to wildlife. Deep snow restricts use by ungulates and carnivores in winter. High densities of porcupines, hoary marmots, and Columbian ground squirrels occur on some sites.

PL - PEYTO LAKE ECOSECTION

The Peyto Lake (PL) Ecosection concept incorporates: Upper Subalpine vegetation; morainal landforms of calcareous till, mainly Till C (calcareous, medium textured); and well to moderately well drained Eutric Brunisols. Vegetation ranges from Engelmann spruce-subalpine fir closed forest at lower elevations to a pattern of heath tundra plus subalpine larch open forest at higher elevations. Three PL Ecosites (Table 117) differ in vegetation pattern, parent material characteristics and subdominant soils. Fig. 14 illustrates topographic relationships among PL1, PL4, and several other Ecosites associated with calcareous bedrock.

GEOMORPHOLOGY

PL1 and PL4, restricted to the Main Ranges and most abundant in the eastern Main Ranges, occur on morainal landforms composed mainly of Till C (calcareous, medium textured) overlying resistant limestone bedrock. In the few tracts adjacent to Chancellor Formation slates, Till B (non- to weakly calcareous, medium textured) and Till B-Till C intergrades also occur. In contrast, PL6, which is restricted to the geologically complex Western Ranges, occurs on various till mixtures. Overall, Tills C and D (calcareous, fine textured) are codominant, Till B is subdominant and intergrades among the three also occur. Minor amounts of Till A (noncalcareous, coarse textured) are also present in some PL6 tracts. PL6 landforms may have thin layers of residuum between the till and bedrock where the

Table 117. Definitive features of Peyto Lake (PL) Ecosites.

Ecosite	Landform	Soils	Vegetation
PL1	Till C; blanket over inclined, hummocky & ridged bedrock	Orthic & Eluviated Eutric Brunisols	Engelmann spruce-subalpine fir forest (C21 > C15)
PL4	Till C; blanket & veneer over inclined, hummocky & ridged bedrock	Orthic & Eluviated Eutric Brunisols > Orthic Humo-Ferric Podzol	heath tundra (L5) > subalpine larch open forest (C23)
PL6	Tills C & D > B; veneer & blanket over inclined & hummocky bedrock	Eluviated Eutric Brunisol > Eluviated Dystric Brunisol	Engelmann spruce-subalpine fir forest (C15, C21)

bedrock is recessive. The residuum grades to till above, to consolidated bedrock below and ranges from calcareous to noncalcareous and from medium to fine textured (Residua A, B, and C).

Thin veneers of Eolian material B (altered, medium textured) sporadically mantle PL1 landforms but are more extensive on PL4 and PL6. Mixtures of eolian material and till, generated by solifluction, soil creep and tree throw, are common in upper sola of PL6 soils. Eolian veneers are more likely to be intact on gentle slopes where disturbance is less than on steep slopes. Colluvial and fluvial materials also occur in minor amounts as inclusions.

Landform surface expression usually reflects the underlying bedrock which is overlain by either morainal blanket or veneer. Morainal veneers dominate PL tracts with the modifier X. The longest slopes are straight, reflect inclined bedrock and occur on valley walls. These grade to hummocky or ridged topography in valley and pass floors and in cirque basins. Most tracts have complex slopes of 15 to 70% and are dominated by irregular topography or by combinations of straight and irregular slopes. Many slopes, particularly in PL1 and PL6, are dissected by gullies.

The hummocky surface of some PL tracts is due to deposition by rock glaciers rather than bedrock control. These extinct rock glaciers, with deeper, stonier till than normal, are often hummocky and such tracts are labelled by the modifier F. The PL4F tract at Goodsir Pass has a steeply sloping, lobate, well defined, front margin culminating in a series of prominent, arcuate, sometimes dissected ridges. Active talus backs the landform. These features suggest that this PL4F tract is an extinct rock glacier which originated as a protalus rampart. Another similar tract (PL4F+M) occurs below Split Peak. The irregular, hummocky to ridged surface of a PL1F tract near Kaufmann Lake is probably due to extensive bedrock failure and localized karst features.

SOILS

Characteristic soils of the PL Ecosection are well to moderately well drained Eutric Brunisols. The various soils (Table 117) have characteristics grouped around taxonomic boundaries. Eutric Brunisols occur on calcareous tills that dominate PL but Dystric Brunisols are subdominant in PL6 where Till B is subdominant and weathering of carbonates is deep. B horizon development is moderate to strong and ranges from Bm and Bf (Brunisolic soils) to podzolic Bf (Podzolic soils). Bf and podzolic Bf usually only develop where Eolian material B is a significant constituent of upper sola, as in PL4. Orthic Humo-Ferric Podzols, subdominant in PL4 and accessory soils in PL1, rarely occur in PL6 because B horizons with high extractable iron and aluminum also have high clay content. The low Fe+Al:clay ratios (<0.5) exclude them from Bf or podzolic Bf (C.S.S.C. 1978b). Soils with Bhf and podzolic Bhf (Orthic Ferro-Humic Podzols) also occur occasionally and the classification of PL4

Podzolics at the great group level is often tenuous when based on field characteristics alone. An illustration of PL soils (Table D24) is from a PL1 tract in the eastern Main Ranges of BNP. It has finer than modal textures in the weakly mixed upper solum. Otherwise, it is similar to PL1 soils in KNP.

A horizon development varies as a function of humus incorporation, surficial material, slope gradient and disruption or mixing. Ae horizons, occurring most extensively in PL6, are discontinuous under forests. Under the heath tundra plus larch open forest pattern of PL4, thin Ah or Ahe horizons replace or overlie Ae horizons. Eutric and Dystric Brunisols are divided, according to Ae horizon thickness, into Orthic (little or no Ae) and Eluviated (>2 cm Ae) subgroups. Orthic and Eluviated Eutric Brunisols are codominant in PL1 and PL4. In PL6, Eluviated subgroups are prevalent and Orthic Eutric and Orthic Dystric Brunisols are accessory soils. Orthic Melanic Brunisols, with Ah horizons ≥10 cm, occur as accessory soils in PL4. Lithic phases and soils affected by solifluction, cryoturbation, tree throw and other disturbances (turbic phases) are important features of PL4 and PL6. The few tracts of PL1X and PL4X are dominated by lithic phases. Eluviated Dystric Brunisols are inclusions in a few PL1 tracts adjacent to Chancellor Formation slaty bedrock.

VEGETATION

Engelmann spruce-subalpine fir forest dominated by the Engelmann spruce-subalpine fir/grouseberry (C15) and Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) v.t.s characterizes PL1 and PL6. C21 is much more extensive than C15 in PL1, but in PL6 the two types are equally abundant. Small stands of the subalpine larch-subalpine fir/grouseberry-everlasting (C23) and Engelmann spruce-subalpine fir/heather/feathermoss (C34) v.t.s occur at higher elevations in some PL1 and PL6 tracts. PL1A and PL6A have 20 to 50% of the area modified by snow avalanching. Modification is mainly to vegetation and avalanche v.t.s such as subalpine fir-willow (S2), fleabane-valerian (H16) and heather-everlasting (L5) occur on avalanche paths. Seral, post-fire vegetation dominates the few tracts of PL1B and PL6B. Vegetation on these landscapes is Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4) in the PL6B tract northwest of Luxor Pass and hairy wild rye-wild strawberry-fireweed (H5) and fireweed-meadow rue (H22) in the PL1B tract near Vermilion Pass. Moist to wet v.t.s, such as Engelmann spruce-subalpine fir/valerian-fleabane (O9) and willow/cinquefoil (S8), occur in seepy gullies and depressions.

PL4 is dominated by a vegetation pattern in which L5 is more abundant than the subalpine larch-subalpine fir/heather (O13) v.t. O13 normally exists as discrete patches of trees but includes islands of krummholz on exposed sites or at the Upper Subalpine-Alpine boundary. Within the elevational range of PL4, tree islands cover about 50% of the landscape at lowest elevations and 5% at the highest elevations. The mountain avens-snow willow-moss campion (H1) v.t. sometimes replaces L5 on exposed ridges and crests. The Engelmann spruce-subalpine fir/heather (O10) v.t. occasionally replaces O13 in KNP. O10 is characteristic of PL4 in JNP and northern BNP (Walker *et al.* 1982d). Modification of the vegetation by avalanching, although often difficult to identify except by reduced tree cover, is an important feature of PL4A. Seepy depressions may have various moist to wet v.t.s such as Engelmann spruce-subalpine fir/valerian-fleabane (O9), fleabane-valerian (H16) and willow/cinquefoil (S8).

WILDLIFE

PL1 Wildlife Features

Ungulates: PL1 is moderately important overall. It is highly important to elk in summer and moderately important to goats. Low use by mule deer was recorded in several tracts and one tract on Spar Mountain had low use by bighorn sheep. Light browsing was recorded on false azalea (***Menziesia glabella***), rhododendron (***Rhododendron albiflorum***) and willow (***Salix*** spp.). Deep snow permits only limited winter use.
Carnivores: PL1 is moderately important overall and highly important to martens.
Small Mammals: Associations 3 and 6.

Table 118. Wildlife features of PL Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
PL1	medium	elk	medium	marten	medium	pika	high
PL4	low		medium	wolverine	medium	marmot	low
PL6	low	moose	medium	marten	medium	porcupine	low

A moderate number of species occurs here at moderate densities. Pikas are found at high densities on some tracts.

Breeding Birds: Communities 7 and 8.

A high density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Hermit Thrush, Mountain Chickadee and Varied Thrush.

PL4 Wildlife Features

Ungulates: PL4 is of low importance, receiving only light use in summer and fall from elk and mountain goats. Winter use is precluded by deep snow. Snow as deep as 1.5 m was recorded in January.

Carnivores: PL4 is of moderate importance being of high importance to wolverines.

Small Mammals: Associations 5, 1 and 3.

A large number of species occurs here at low to moderate densities. Hoary marmots occur at high densities as do pikas, Columbian ground squirrels, golden-mantled ground squirrels and red-backed voles on some tracts.

Breeding Birds: Communities 7, 17 and 18.

A low density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Chipping Sparrow.

PL6 Wildlife Features

Ungulates: PL6 is relatively uncommon, being restricted to the Brisco and Stanford ranges in western KNP. It is of low importance overall, but of high importance to moose in summer. Tracts in upper Kindersley and Kimpton creeks are moderately important to bighorn sheep in summer. Winter use is prevented by deep snow.

Carnivores: PL6 is of high importance to martens and of moderate importance overall.

Small Mammals: Associations 3 and 6.

PL6 is of moderate importance. High densities of porcupines occur on some tracts, particularly with C15 v.t.

Breeding Birds: Communities 7 and 8.

A low density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Clark's Nutcracker.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The PL Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and modified to better accommodate similar landscape (1.8%) in KNP. Likewise, PL1 (0.7%) and PL4 (0.6%) were extended, with minor modifications, to KNP. PL6 (0.4%) was added for lithologically complex morainal landforms of the Western Ranges in KNP.

PL is the Upper Subalpine counterpart of Lower Subalpine Bryant (BY) Ecosection. The Egypt (EG) and Larch Valley (LV) Ecosections resemble PL but occur on non- to weakly calcareous tills dominated by Dystric Brunisols. The BP2 tract at Goodsir Pass has irregular topography and stoniness that resemble the adjacent PL4F tract, but the BP2 encompasses a landslide deposit.

Use is limited by steep slopes or irregular topography. Locally, use may be affected by shallow soils and gullies. Removal of vegetation may result in erosion on steep slopes and revegetation will be slow in PL4.

PL is moderately important to wildlife. Deep snow restricts use by ungulates and carnivores in winter. Porcupines and some small mammals that hibernate are very common.

PP - PIPESTONE ECOSECTION

The Pipestone (PP) Ecosection concept incorporates Lower Subalpine vegetation; apron and level landforms consisting of calcareous, fluvial and glaciofluvial materials; and rapidly to moderately well drained Regosolic soils. The two PP Ecosites (Table 119) differ in vegetation and landform. PP3 occurs on valley floors along Tokumm, Haffner, and Verdant creeks and the Vermilion River. The only tract of PP4 occurs on the valley bottom along a tributary of Tokumm Creek. Fig. 22 illustrates the typical topographic position of PP3.

GEOMORPHOLOGY

Fluvial material B (calcareous, coarse-stratified) is the main constituent of PP3 landforms. Glaciofluvial material B (calcareous, coarse textured) is also an important constituent of level PP3 tracts along the Vermilion River where it underlies Fluvial material B. Sometimes it is difficult to distinguish the two water-laid deposits. Fine textured sediments, mainly Fluviolacustrine material B (calcareous, fine-stratified), also occur occasionally as veneers on gently sloping aprons or interbedded with fluvial and glaciofluvial deposits in level landforms. Other geomorphic layers in the aprons exhibit a poorly sorted, till-like material indicative of mudflows, thought to be important in fan and apron construction.

The PP4 tract on widened valley bottomland, down valley from the largest glacier in KNP, is dominated by Glaciofluvial material B. The material is deposited where the overloaded meltwater stream braids after descending through a canyon cut in the steep bedrock slope above the tract. Glacial landforms surrounding the south end of the tract have constricted stream flow forcing the braided channels to converge into one or two major channels that have breached the damming landform and exit the tract. The constriction of stream flow has also resulted in impeded soil drainage and the deposition of sediments with finer textures than the glaciofluvial material. Thus, Fluviolacustrine material B and probably some Fluvial material B mantle glaciofluvial deposits on the lower quarter of the tract. In contrast, the upper third is predominantly unvegetated, freshly deposited and eroded glaciofluvial material.

PP3 surface expression ranges from aprons with straight to concave slopes to level plain and subtly terraced terrain bordering major streams. Slopes are 0 to 15%. Simple slopes are predominantly level whereas complex slopes include both the apron and level landforms.

The PP4 tract is effectively level with a slope of 0% at the lower end to >5% on the small actively aggrading fan at the upper boundary. Slope on most of the tract is <2%. Slope continuity on both Ecosites is often subtly broken by stream channels (Eroded modifier, C.S.S.C. 1978a), including narrow, elevated ridges along the banks. Channels are better expressed and more abundant on level landforms than on aprons.

Table 119. Definitive features of Pipestone (PP) Ecosites.

Eco-site	Landform	Soils	Vegetation
PP3	Fluvial material B; apron & level	Orthic & Cumulic Regosols	Engelmann spruce-subalpine fir forest (C13)
PP4	Glaciofluvial material B; level; eroded	Orthic Regosol	herb mat (H8)

SOILS

PP is characterized by rapidly to moderately well drained Regosolic soils with depositional layers rather than pedogenic horizons. These indicate current or recent fluvial and glaciofluvial deposition, which precludes the development of pedogenic horizons. Cumulic Regosols, codominant in PP3, show both pedogenic and physical incorporation of organic material either as organic matter that varies irregularly with depth or as buried A horizons, as in the example pedon (Table D25, Plate 44). Such soils indicate intermittent deposition and that surficial organic layers formed during inactive periods. The example pedon is from a PP3 tract in the eastern Main Ranges of BNP but illustrates Cumulic Regosols of PP3 in KNP. Orthic Regosols, codominant in PP3 and dominant in PP4, are more uniform in color and organic matter content indicating more frequent and continuous geomorphic activity. Eutric Brunisols occur in minor amounts on PP3 and are restricted to slightly elevated sites that have escaped fluvial activity for long periods.

PP3 soils are mainly well to moderately well drained and PP4 soils are rapidly to moderately well drained. However, level landforms have a few imperfectly drained sites where seasonally high water tables affect the soils. Thus, Gleyed Regosols are accessory soils in both PP3 and PP4 and have faint to distinct mottles within 50 cm of the mineral surface. The lower end of the PP4 tract is wetter than modal due to constriction of drainage and stream flow by the surrounding glacial landforms. Here, poorly drained Rego Gleysols are likely associated with the Gleyed Regosols.

VEGETATION

PP3 and PP4 have different vegetation. PP3 is characterized by Engelmann spruce-subalpine fir forest, mainly Engelmann spruce-subalpine fir/feathermoss (C13) although variations of this v.t. are common. Stands near streams may contain willow (*Salix farriae*) or green alder (*Alnus crispa*) and resemble the Engelmann spruce-subalpine fir/green alder (C25) v.t. In the Vermilion River valley where vegetation is transitional between Montane and Lower Subalpine, the forest includes white spruce and spruce hybrids and successional stages from early to mature occur over short distances on level landforms. The main successional sequence is from yellow dryad-willow herb (H8), occasionally sedge-saxifrage (H3, Corns and Achuff 1982), along recently active river banks through white spruce/shrubby cinquefoil/bearberry (O3, Corns and Achuff 1982) and spruce or spruce-fir with willow to C13 or, occasionally, white spruce/buffaloberry/feathermoss (C37) on older, more stable PP3 sites. The white spruce-subalpine fir/bunchberry-horsetail (C41) v.t. also occurs occasionally, usually as small stands restricted to depressions such as channels where seasonally high water tables impede soil drainage. At higher elevations within the Lower Subalpine, spruce-fir stands may occasionally contain some false azalea (*Menziesia glabella*) and resemble the Engelmann spruce-subalpine fir/false azalea (C14) v.t. Tracts with the modifier A (PP3A) have 20 to 50% of the area modified by snow avalanching. Modification is mainly to vegetation and avalanche v.t.s such as subalpine fir-willow (S2) and green alder/fern (S13) occur on avalanche paths.

PP4 is characterized by herb meadows, mainly, the yellow dryad-willow herb (H8) v.t. which is composed mainly of yellow dryad (*Dryas drummondii*) colonizing the recent sediments. The central third to half of the PP4 tract is dominated by H8 but includes scattered spruce trees grading to spruce open forest downslope. The upper third of the tract is unvegetated with a few scattered plants on freshly deposited and eroded material. The lower quarter of the tract is wetter than modal for PP4 and has various moist to wet v.t.s including herb meadow similar to sedge-saxifrage (H3, Corns and Achuff 1982), shrub thicket resembling willow/horsetail (S7, Corns and Achuff 1982), and possibly dwarf birch-shrubby cinquefoil-willow/brown moss (S1) shrub meadow. Intergrades among these and H8 also likely occur.

WILDLIFE

PP3 Wildlife Features

Ungulates: PP3 is of high importance to moose in winter even in areas such as Verdant Creek where January snow depths average 100 cm. Browse use is low in C13, however PP3 is always associated with riparian shrub communities which provide a source of winter forage. PP3 in the Vermilion Valley is used moderately by elk in spring and fall, probably because of its association with Highway 93 and small amounts of H8 v.t.

Carnivores: PP3 is moderately important to most carnivores.

Small Mammals: Association 3.

A high number of species occurs here at moderate to high densities. High numbers of porcupines and very high numbers of red-backed voles occur.

Breeding Birds: Community 20.

A medium density of birds was recorded. Species diversity is high. Based on density indices derived from circular census plots, this Ecosite is highly important to Golden-crowned Kinglet, Swainson's Thrush, Spotted Sandpiper, American Robin and Cedar Waxwing.

PP4 Wildlife Features

Ungulates: The single tract of PP4 within KNP occurs in the upper Tokumm Creek area and was not sampled for ungulates. However, the predominant H8 v.t. would make it of moderate importance to elk in summer and fall. High snow accumulation prevents use in winter.

Carnivores: PP4 is of low importance.

Small Mammals: Association 4.

A few species occur here at low densities.

Breeding Birds: Community 15.

A low density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Spotted Sandpiper and Killdeer.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The PP Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and applied to similar landscape (0.4%) in KNP. Likewise, the PP3 (0.4%) and PP4 (<0.1%) concepts were applied virtually unchanged to KNP. Four other PP Ecosites used in BNP and JNP are absent in KNP.

PP is the Lower Subalpine counterpart of the Montane Hillsdale (HD) Ecosection. Altrude 3 (AL3) resembles PP3 but occurs on fluvial landforms with older, more stable surfaces as indicated by the dominance of Brunisolic soils. Hector 1 (HC1) may sometimes be similar to PP3 but HC1 is characterized by wetter soils and open forest indicative of periodically high water tables.

Table 120. Wildlife features of PP Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
PP3	low	moose	medium		high	red-b. vole porcupine	medium
PP4	low	elk	low		low	meadow vole	low

Fluvial and mudflow deposition are sufficiently frequent to maintain the dominant Regosolic soils and is a major factor in use planning. Parts of PP4 are flooded annually. Locally occurring coarse textures and high water tables present problems for sewage disposal. The gravelly coarse textured material is suitable aggregate for construction.

RD - REDOUBT ECOSECTION

The Redoubt (RD) Ecosection concept incorporates colluvial landforms of non- to weakly calcareous, medium textured colluvium (Colluvium B) occurring in the Alpine Ecoregion. Dystric and Sombric Brunisols, Regosols, and Humic Regosols occurring under tundra vegetation are also characteristic. One Ecosite (RD2, Table 121) was recognized. RD2 occurs high on the slopes and tops of ridges and peaks in the western Main Ranges. Fig. 23 illustrates topographic relationships among RD2 and other colluvial Ecosites associated with Chancellor Formation slate.

GEOMORPHOLOGY

RD is geomorphically characterized by colluvial landforms composed of Colluvium B (non- to weakly calcareous, medium textured). Colluvium C (calcareous, medium textured) occurs sporadically in association with limestone layers within the slaty strata. The colluvium occurs as veneers and blankets overlying inclined bedrock, mainly Chancellor Formation slate. The top of the recessive bedrock may be weathered *in situ* forming a veneer of Residuum A (non- to weakly calcareous, medium textured) between the colluvium and consolidated bedrock. Slopes are both simple and complex ranging from 45 to >100%. Tracts with complex slopes straddle ridges and encompass steep slopes on valley walls plus gentle to moderate slopes of subdued ridges, small cirques and passes. Such landscapes include other genetic materials and landforms: Residuum A on crests; colluvial aprons, including talus, bordering cirque and pass floors; small, isolated, morainal landforms; and exposed bedrock. Bedrock exposures generally blend into the slope because the recessive strata rarely form massive, precipitous cliffs. Exposed bedrock is most abundant (about 50%) on the RD2+R tract on Numa Mountain.

Colluvial activity varies across the landscape and includes solifluction, snow avalanching, soil creep and slope wash. Thus, some sites are comparatively stable and well vegetated with pedogenic soil development while others are very active, often rubbly, and unvegetated. However, many RD2 soils have disrupted and mixed horizons produced by solifluction. Veneers of Eolian material B (altered, medium textured) are rare. Due to geomorphic processes, eolian material is usually absent or mixed with colluvium in upper soil horizons. Colluviation has resulted in a more than normal proportions (20-50% normally) of unvegetated colluvial rubble on RD2+CR.

SOILS

Soil development and distribution on RD2 reflects variations in kind, intensity, and duration of geomorphic processes. Orthic Regosols occur where recent activity has inhibited B horizon development. Likewise, A horizon development may be inhibited or, Ah horizons, if present, rarely exceed

Table 121. Definitive features of Redoubt (RD) Ecosites.

Ecosite	Landform	Soils	Vegetation
RD2	Colluvium B; veneer & blanket over inclined bedrock; solifluctcd	Turbic phases: Orthic Sombric Brunisol, Orthic Regosol > Orthic Melanic Brunisol	avens tundra (H1), herb tundra (H17), heath tundra (L5)

10 cm in thickness. Turbic phase pedons with disrupted, mixed, buried, or overturned A and C horizons are common. Regosolics dominate RD2+CR.

Brunisolic soils occur on sites of low geomorphic activity in which there has been sufficient time for B horizon development. Turbic phase Orthic Sombric Brunisols are dominant and have: thick (>10 cm) Ah horizons; moderately to well developed Bm horizons; mixed, contorted, displaced, or disrupted upper sola; and strongly to extremely acidic (pH <5.5) lower sola. The subdominant soils, turbic phase Orthic Melanic Brunisols are similar but have medium acid to neutral (pH≥5.5) lower sola. They are developed in weakly calcareous colluvium where weathering has been insufficient to acidify the sola. Turbic phases of these Brunisolics are more abundant than non-turbic profiles. Hence, the example pedon (Table D26, Plate 45), from an RD2 tract above Ottertail Pass, illustrates the strongest development because it is non-turbic. The stratified coarse fragments and possible inclusion of eolian material in the Bhf horizon of this profile indicate that colluvial deposition likely occurred episodically.

In contrast to Regosolic soils, Ah horizons in Brunisolics are usually >10 cm and often have been physically thickened by low intensity geomorphic processes. Orthic Dystric and Orthic Eutric Brunisols, with thin or no Ah horizons, also occur as accessory soils. Ae horizon development is minimal. Lithic phases are common in association with colluvial veneers. RD2 soils are predominantly well to moderately well drained.

VEGETATION

RD2 is characterized by a mosaic of tundra v.t.s, mainly mountain avens-snow willow-moss campion (H1), everlasting-grouseberry (H17) and heather-everlasting (L5). H1 occurs at the highest elevations, on exposed ridge crests, on moderately active sites, and on soils with high pH and lime near the surface. H17 and L5 predominate on more stable, protected sites (Plate 46). The most active localities are usually unvegetated. RD2+CR is dominated (50-80%) by sparsely vegetated to unvegetated colluvial rubble interspersed with patches of denser vegetation.

WILDLIFE

RD2 Wildlife Features

Ungulates: RD2 is of moderate importance to mountain goats year round, particularly where blown free of snow in winter. An RD2+CR tract on the southern end of Hawk Ridge receives high use from bighorn sheep in summer.

Carnivores: RD2 is generally of low importance, although moderately important to coyotes and cougars in summer.

Small Mammals: Associations 5 and 1.

A moderate number of species occurs here and pikas, hoary marmots and Columbian ground squirrels occur at high densities on some tracts.

Breeding Birds: Communities 17 and 18.

Table 122. Wildlife features of RD Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
RD2	medium	sheep	low		medium	pika marmot Columbian gr. squirrel	low

A low density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Water Pipit and Rosy Finch.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The RD Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and modified to better accommodate similar landscape (0.5%) in KNP. A new Ecosite, RD2 (0.5%), was added to distinguish KNP landscape with subdominant Melanic Brunisols from RD1 in BNP and JNP where soils with pH >5.5 are uncommon. This distinction is also linked to the unpredictable occurrence of low lime colluvium in RD2, to differences in weathering intensity and other differences in soil, landform, and vegetation.

RD is the Alpine couterpart of the Upper Subalpine Whitehorn (WH) and the Lower Subalpine Fairview (FV) Ecosections. The Bow Summit (BS) and Tekarra (TK) Ecosections resemble RD. However, BS occurs on calcareous colluvium (Colluvial materials C and D) and is characterized by more alkaline, often calcareous soils including Eutric and Melanic Brunisols and Regosols. TK occurs on Colluvium A (noncalcareous, coarse textured) derived from quartzitic bedrock.

Use is limited by steepness and colluviation. Removal of vegetation may increase erosion and revegetation will be slow. RD is important to goats as year round range and is often blown snow-free. High densities of pikas, golden-mantled ground squirrels, and hoary marmots occur here.

SB - SAWBACK ECOSECTION

The Sawback (SB) Ecosection concept incorporates: landforms composed predominantly of calcareous colluvium, well drained Brunisolic and Regosolic soils, and Lower Subalpine vegetation including both open and closed coniferous forests and avalanche v.t.s. Six SB Ecosites (Table 123) were recognized.

SB occurs at middle elevations on steep slopes throughout KNP, usually in association with calcareous bedrock. The valley wall position makes it likely that SB landscapes are post-glacial. Figs. 13, 17 and 22 illustrate topographic relationships among SB and other Ecosites.

GEOMORPHOLOGY

The predominant genetic material characterizing the SB Ecosection is Colluvium C (calcareous, medium textured). SB2 and SB3 are restricted to consistently calcareous areas of the Main Ranges and are usually underlain by resistant carbonate bedrock. Colluvium C is thus by far predominant in these two Ecosites. SB1 also occurs in the Main Ranges, chiefly on Colluvium C, because topography and snow accumulation here are conducive to snow avalanching.

Fig. 22. Landscape schematic of topographic relationships among SB, WF and other Ecosites.

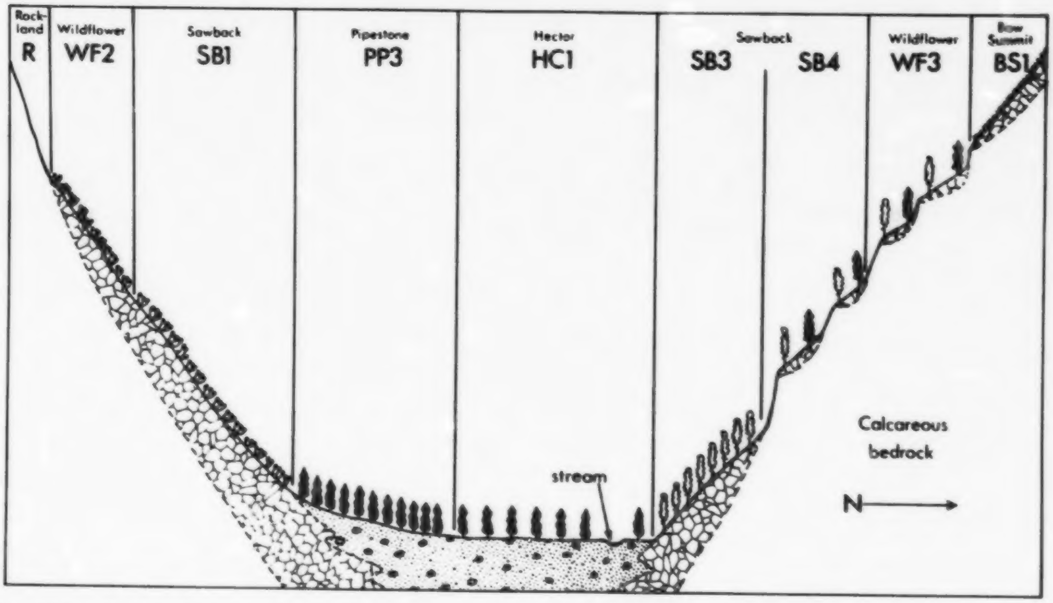

Rockland
R
Wildflower
WF2
Sawback
SB1
Pipestone
PP3
Hector
HC1
Sawback
SB3
SB4
Wildflower
WF3
Bow Summit
BS1
stream
Calcareous bedrock
N

Table 123. Definitive features of Sawback (SB) Ecosites.

Eco-site	Landform	Soils	Vegetation
SB1	Colluvium C; blanket over inclined berock, apron; avalanched	Orthic Eutric Brunisol, Orthic Regosol, Orthic & Cumulic Humic Regosols	Avalanche complex 1 > Engelmann spruce-subalpine fir forest (C14)
SB2	Colluvium C; blanket over inclined bedrock, apron	Orthic & Eluviated Eutric Brunisols, Orthic Regosol	Engelmann spruce-subalpine fir forest (C14)
SB3	Colluvium C; blanket & veneer over inclined bedrock	Orthic Eutric Brunisol, Orthic Regosol	lodgepole pine forest (C3, C6, C19)
SB4	Colluvium C; veneer & blanket over inclined bedrock + exposed bedrock	Lithic phases: Orthic Eutric Brunisol, Orthic Regosol, Orthic Humic Regosol; + nonsoil	mixed coniferous open forest (O4), Douglas fir open forest (O5)
SB6	Colluvium C & D > B; veneer & blanket over inclined bedrock	Orthic Eutric Brunisol > Orthic Dystric Brunisol, Eluviated Eutric Brunisol	Engelmann spruce-subalpine fir forest (C14)
SB7	Colluvium C & D > B; veneer & blanket over inclined bedrock	Orthic Eutric Brunisol > Orthic Dystric Brunisol, Eluviated Eutric Brunisol	lodgepole pine forest (C10, C20)

SB6 and SB7, occurring in the lithologically intricate Western Ranges (Fig. 2), are also dominated by calcareous colluvium but include Colluvium D (calcareous, fine textured) in addition to Colluvium C. A third material, Colluvium B (non- to weakly calcareous, medium textured), is locally important and of sufficient areal extent to be the subdominant genetic material unit (Table 123). Minor amounts of Colluvium A (noncalcareous, coarse textured) are also present in some SB6 and SB7 tracts. Intergrades among the four colluvial materials also occur. The colluvium in SB6 and SB7 often overlies a veneer of weathered bedrock if the bedrock is inherently soft. This veneer may be Residuum A, B or C depending on the bedrock calcareousness and texture, and there is often a correspondence between the characteristics of the residuum and the overlying colluvium. Textures of both are usually medium to fine.

SB4 spans the park, transcending geological subprovince boundaries. Colluvium C is the principal genetic material, even in the Western Ranges, because SB4 is usually expressed as a pattern of shallow colluvium plus bedrock outcrops on steep, rugged, bench and cliff topography. Resistant carbonate bedrock, rather than softer slate or calcareous shale, is most often expressed in this way, and the colluvium reflects this origin.

The colluvium in SB occurs most frequently as uniform blankets or veneers, the thinner of which only subtly mask the underlying bedrock. However, in SB4 the colluvium is normally discontinuous over bedrock. SB1 often includes colluvial aprons in addition to the blankets. These aprons are frequently a series of coalescing colluvial cones that have developed below steep rock walls. Couloirs in the rock wall channel avalanches, springtime meltwater, and occasional mudflows onto the cones. Thus, landforms in SB1 below couloirs are often a mixture of intercalated colluvial, fluvial, and mudflow materials. Stability of the mineral surface varies considerably in SB1 and depends on the amount of debris eroded or deposited. Generally, couloirs and fan-shaped localities below them are the most active. Small fluvial and mudflow cones may occur along the base of forested SB colluvial slopes.

Long, straight inclines are typical of SB. Slopes are 45 to >100%, although slopes <55% are not extensive. SB4, with its cliff and bench topography, has less uniform slopes that frequently average >70%.

In general, the steeper the slope, the broader the area that adjusts to restabilize the slope after disturbances such as the uprooting of trees. Steep, southerly aspects are often dry and have mineral soil exposed to erosion. The tendency towards surface instability in colluvium is heightened by its loose packing. Thus, intact surficial eolian veneers are absent in SB, except for rare occurrences in the most stable areas.

SB1 characteristically has >50% of the area affected by snow avalanching which also occasionally influences ≤20% of SB Ecosites other than SB1. If 20 to 50% is avalanched, the modifier A is added to the map symbol. Avalanched areas are most common in the Main Ranges because snowfall is highest and the rugged topography contains many avalanche starting zones. Many SB4 tracts, especially in the Main Ranges, are partially modified by avalanching. Thus, the modifier A is included parenthetically in the legend.

SOILS

Most soils of the SB Ecosection are moderately well to rapidly drained and are either Brunisolic or Regosolic (Table 123). The predominant soils are Orthic Eutric Brunisols occurring on a majority of the calcareous colluvium where stability has been sufficient for soil development (≥1000 years). Most of these Orthic Eutric Brunisols have little or no A horizon development, B horizons that are weakly to moderately developed (little extractable iron, aluminum, and humus) and 5 to 30 cm thick, and moderately to extremely calcareous C horizons. The lower sola are medium acid to mildly alkaline (pH >5.5). The other characteristic soils are interspersed with and are usually taxonomically related to Orthic Eutric Brunisols.

Eluvial (Ae) horizons are often present in the most strongly weathered, most stable Eutric Brunisols. When the Ae is $\geq$2 cm thick, the profile is an Eluviated Eutric Brunisol. In the Main Ranges, these strongly developed soils are codominant with Orthic Eutric Brunisols and Orthic Regosols in SB2, and are accessory soils in the subdominant forested portions of SB1. In the Western Ranges on SB6 and SB7, Eluviated Eutric Brunisols are a subdominant member of the soil pattern. The eluviation here may reflect the low-lime, readily weathered parent material as much as a rigorous weathering regime.

Orthic Dystric Brunisols are the other subdominant member in SB6 and SB7. These soils develop on stable to moderately active sites where the parent material is low in lime or is lime-free. B horizons are strongly to very strongly acid (pH 4.5 to 5.5). Related Eluviated Dystric Brunisols (Ae $\geq$2 cm) are accessory soils in SB6 and SB7.

On more highly calcareous colluvium, geomorphic disturbance often severely retards soil development by exposing or incorporating fresh calcareous material in the solum. Soils at these incipient stages of development are Regosolic. Orthic Regosols are one group of characteristic codominant soils in SB1, 2, 3 and 4. The Orthic Humic Regosols of SB1 and SB4 probably result from surface disturbance mechanically incorporating organic material into the topmost mineral material, creating an Ah horizon $\geq$10 cm thick. Fresh mineral material is often deposited on avalanched colluvial slopes, especially below couloirs. The activity often buries organic-rich layers, creating the accessory Cumulic Regosols (Ah <10 cm) and codominant Cumulic Humic Regosols (Ah $\geq$10 cm) of SB1.

Infrequently, surface colluviation may mechanically incorporate humus into the topmost 10 cm or more in areas where Brunisolic soils have previously developed. The resultant Orthic Melanic Brunisols are accessory soils in SB1 and SB4.

Colluvium often is shallow, especially on steeper slopes, and while lithic phases occur sporadically in any SB Ecosite, they are characteristic of SB4 and other SB tracts with the modifier X. Numerous nonsoil areas in which bedrock outcrops or is mantled by <10 cm of overburden, are interspersed with lithic soils on SB4.

Turbic soil phases also may occur on any SB Ecosite. Blowdown of trees is probably the most common cause of soil disruption on forested slopes. Avalanching may uproot vegetation (SB1), while intense colluvial activity on steep, unstable slopes disturbs upper horizons.

A pedon (Table D27, Plate 47) illustrating SB soils, particularly SB6 and SB7 of the Western Ranges, is from an SB6 tract in upper Sinclair Creek valley. The colluvium texture in this profile, though medium, tends towards fine and solum pH is near the acidic end for Eutric Brunisols, apparently because of low initial carbonate content. The colluvium overlies residual veneer which overlies bedrock. The Bmu horizon meets all criteria but one for a Podzolic B; the Fe+Al:clay ratio is too low (<0.05) for Bf (C.S.S.C. 1978b). The pedon is both lithic and turbic phase, a common feature in the Western Ranges where these phases are accessory characteristics of SB6 and SB7.

VEGETATION

The v.t.s that typify each SB Ecosite (Table 123) reflect differences in exposure, geomorphic activity, and fire history. The Engelmann spruce-subalpine fir/false azalea (C14) v.t., typical of SB2 (Main Ranges) and SB6 (Western Ranges), is predominant on slopes that have been stable longest (Plate 48). SB2 and SB6 tend to occur on northerly aspects. Both have the Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) v.t. as an accessory.

SB Ecosites that are predominantly pine forest have greater vegetational differences from east to west. SB3 (Main Ranges) has the lodgepole pine/juniper/bearberry (C3), lodgepole pine/buffaloberry/showy aster (C6) (Plate 49) and lodgepole pine/buffaloberry/twinflower (C19) v.t.s, while SB7 (Western Ranges) has chiefly lodgepole pine/green alder/feathermoss (C10) and lodgepole pine/false azalea/grouseberry (C20). Both SB3 and SB7 tend to be on southerly aspects. Recently burned tracts (*e.g.* near Vermilion Pass) are SB3B and have the lodgepole pine/twinflower-fireweed (S5) v.t.

Steep, rugged SB4 throughout KNP has more heterogeneous vegetation than the Ecosites mentioned above. The Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4) and Douglas fir/juniper/bearberry (O5) v.t.s predominate. Both v.t.s occur in southwestern KNP with O4 at higher elevations than O5. In northeastern KNP, O4 is by far predominant. Unvegetated areas with <20% cover are an accessory feature, usually associated with steep bedrock outcrops. On SB4A, numerous v.t.s occur on the avalanched portions, most notably aspen/hairy wild rye-showy aster (C22).

The vegetation of avalanched portions of SB1 is Avalanche complex 1 (Table 123, Plate 50). Avalanche complex 1 consists of subalpine fir-willow (S2), aspen-dwarf birch/bearberry (S16), hairy wild rye-wild strawberry-fireweed (H5) and aspen/hairy wild rye-showy aster (C22), plus intergrades. S2 is most abundant. Forested strips (<50%) between avalanche tracks resemble SB2 and are chiefly the Engelmann spruce-subalpine fir/false azalea (C14) v.t. Unvegetated areas (<20% cover) occur occasionally on the geomorphically most active sites of SB1, such as talus cones or channels below couloirs.

WILDLIFE

SB1 Wildlife Features

Ungulates: This predominately avalanched Ecosite is moderately important to elk and moose in summer and, where snow depths are favorable, highly important to wintering moose. Browse use is moderate to high, particularly where moose overwinter (*e.g.* SB1 above Paint Pots and lower Tokumm Creek). Heavy browsing occurs on willow (*Salix glauca, Salix scouleriana, Salix vestita*) and poplar (*Populus trichocarpa, Populus tremuloides*).

Carnivores: SB1 supports a large number of species at low to moderate densities.

Small Mammals: Associations 8 and 2.
A high number of species occur here at low to moderate densities. Avalanche shrub and meadow communities have moderate to high densities of long-tailed voles, western jumping mice, meadow voles, masked shrews and least chipmunks. Forested areas (C6, C14) are dominated by red-backed voles.

Breeding Birds: Communities 7, 8 and 12.
A low density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to MacGillivray's Warbler and Dark-eyed Junco.

SB2 Wildlife Features

Ungulates: SB2 is moderately important, particularly where the forest cover is broken by avalanche slopes. January snow depths approach 1.0 m, which restricts winter use to all but moose. Moose wintered in a SB2 tract above Tokumm Creek in 1982-1983.

Carnivores: SB2 is of moderate importance to most carnivores, but of high importance to martens.

Small Mammals: Associations 2 and 3.
SB2 has a moderate number of species at low densities. Red-backed vole is the only species at high density.

Breeding Birds: Community 8.
A low density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Yellow-rumped Warbler.

Table 124. Wildlife features of SB Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
SB1	medium	moose	medium		high	pika	low
SB2	medium	elk	medium	marten	low	red-b. vole	low
SB3	medium	mule deer	high	cougar lynx	medium	hare red squirrel	medium
SB4	high	mule deer goat	medium	cougar	high	pika deer mouse	medium
SB6	low	mule deer	medium	marten	low	red-b. vole	high
SB7	medium	mule deer	medium	cougar	low		low

SB3 Wildlife Features

Ungulates: SB3 is highly important to mule deer in summer and fall on the west aspects of the Mitchell Range. Elsewhere in KNP, SB3 is of low importance except in the Vermilion Pass burn where the S5 v.t. is of high importance to wintering moose and of moderate importance to elk and mule deer in summer.

Carnivores: SB3 is highly important to carnivores, especially cougars and lynx.

Small Mammals: Associations 1, 2 and 9.

A moderate number of species occurs here at moderate densities. Snowshoe hares and red squirrels occur at high density. SB3 tracts in the Vermilion Pass burn have a high species diversity, but low relative abundance.

Breeding Birds: Communities 12 and 19.

A medium density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Townsend's Warbler, Pine Siskin, Boreal Chickadee, Brown Creeper, and Golden-crowned Kinglet.

SB4 Wildlife Features

Ungulates: SB4 is of high importance, primarily in winter, but only in the extreme southwest of KNP (Sinclair and Stoddart drainages) where low snow accumulations permit winter use by mule deer, elk and bighorn sheep. The SB4 tract on the southerly aspect of Mount Wardle is very highly important to mountain goats in winter and as a kidding area in spring.

Carnivores: The importance of SB4 is high for cougars in summer and moderate overall.

Small Mammals: Association 1.

A high number of species occurs here, with high densities of deer mice.

Breeding Birds: Communities 2, 3 and 7.

A medium density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Ruby-crowned Kinglet, Yellow-rumped Warbler, and Townsend's Solitaire.

SB6 Wildlife Features

Ungulates: SB6 is generally of low importance to ungulates, however summer use by mule deer and elk is moderate where slide paths with S2, S10, H5 and H22 v.t.s interrupt the predominantly C14 forest. SB6 is restricted to the Brisco and Stanford ranges in the west and southwest portions of KNP.

Carnivores: SB6 is of low to moderate importance to large carnivores. It is highly important to martens and some avalanched tracts have high densities of weasels.

Small Mammals: Associations 2 and 3.
SB6 has a moderate number of species occurring at low densities. Only red-backed voles occur in high numbers.

Breeding Birds: Community 8.
A high density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Winter Wren, Ruby-crowned Kinglet, Pine Grosbeak, Mountain Chickadee, and Hermit Thrush.

SB7 Wildlife Features

Ungulates: SB7 is restricted to the Brisco and Stanford ranges in the west and southwest portions of KNP, as is SB6. It has a slightly higher importance to ungulates than SB6 owing to a higher use by mule deer in summer and fall.

Carnivores: Moderate to high use of SB7 by mule deer and bighorn sheep in the southwestern part of KNP makes it highly important to cougars, especially in winter. SB7 is moderately important to other carnivores.

Small Mammals: Association 3.
A low number of species at moderate densities occurs here.

Breeding Birds: Communities 5 and 19.
A low density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Golden-crowned Kinglet, Townsend's Warbler and Yellow-rumped Warbler.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The SB Ecosection concept originated in the BNP and JNP inventory (Walker *et al.* 1982d) and has been slightly modified for KNP. SB6 and SB7 were added in KNP because of the range of textures and calcareousness in the Western Ranges, and the resultant diversity in vegetation and especially soils.

SB accounts for 9.3% of KNP. Dry Gulch (DG) is the Montane counterpart of SB, while Wildflower (WF) is the Upper Subalpine counterpart, since all three occur on predominantly calcareous colluvium. SB most closely resembles the Fairview (FV) Ecosection but the latter, while Lower Subalpine, occurs on noncalcareous rather than calcareous colluvium and has predominantly acidic soils. SB1 (1.0%) corresponds to the mainly avalanched FV5, SB2 (1.1%) and SB6 (2.3%) to FV6 (spruce-fir), SB3 (1.9%) and SB7 (0.9%) to FV3 (pine), and SB4 (2.1%) to FV4 (steep, lithic).

Steepness and colluviation are major limitations. The Ecosites from most to least active are: SB1 (avalanched), SB4 (craggy), and the others (forested). Removal of vegetation may increase erosion. SB is highly important to wildlife, particularly in the Western Ranges (SB4, SB6, SB7) where low snow depths permit ungulate winter use.

SX - SPHINX ECOSECTION

The Sphinx (SX) Ecosection concept incorporates wetland soils and vegetation occurring on glacial landforms in the Upper Subalpine. In KNP, non- to weakly calcareous, medium textured till (Till B) is the predominant glacial material and *wetland* is applied loosely because the soils and vegetation are only marginally wet. Wetness is due primarily to seasonal seepage following snow melt and soil thaw. Physiographic position on floors and lower slopes of valleys and broad passes plus shallow overburden overlying slowly pervious, Chancellor Formation, slaty bedrock promote saturation of the soil control section in early summer. Over the summer, the soils become progressively drier and the depth to water table increases, disappearing from the control section at many sites. Two SX Ecosites (SX1 and SX2, Table 125) are recognized by meadow and tundra vegetation *vs.* open forest, although there are concomitant soil differences. Fig. 19 illustrates topographic relationships among the SX, Egypt (EG) and Jonas (JN) Ecosites.

GEOMORPHOLOGY

SX is geomorphically characterized by morainal landforms composed of Till B (non- to weakly calcareous, medium textured). Most SX is in the western Main Ranges where the till is derived from Chancellor Formation slate. The slaty bedrock is recessive and the mountain topography is subdued. The top part of this recessive bedrock is often weathered, resulting in a veneer of Residuum A (non- to weakly calcareous, medium textured) sandwiched between the till and bedrock. Only one tract, an SX2A in upper Tokumm Creek valley, occurs in the eastern Main Ranges. It is probably dominated by Till A (noncalcareous, coarse textured), overlies resistant Gog Group quartzite and indicates groundwater discharge. The three SX tracts at Ottertail Pass likely contain some Ice Contact Stratified Drift C (non- to weakly calcareous, variably textured).

Appreciable portions of SX landforms are thinly mantled by a silty veneer with few coarse fragments. This material can be of eolian, fluvial or fluviolacustrine origin but is most often Fluviolacustrine material A (altered, fine-stratified) derived locally by slope wash on surrounding slopes and by deposition along seasonal streams. Redeposited Eolian material B (altered, medium textured) is likely a significant constituent of the fluvial and fluviolacustrine veneers. Thin fen peat layers occasionally mantle the mineral soils but are thinner and less common than peaty layers mantling the Lower Subalpine Consolation Valley 1 (CV1) wetland soils.

Morainal material commonly occurs as a veneer or blanket and the surface expression (Table 125) reflects the underlying bedrock. The longest slopes are straight, reflect inclined bedrock, and occur on lower valley and pass walls. Hummocks and ridges are prevalent on the floors of valleys and passes. Internal relief is generally low even though the slopes are 0 to 45% and most tracts have complex topography. Solifluction is the most common modifier of SX landforms. Disrupted and mixed soil horizons better indicate the effects of solifluction than do surface manifestations such as solifluction lobes and streams.

SOILS

SX is characterized by a complex pattern of imperfectly drained Gleyed Dystric Brunisols, Gleyed Sombric Brunisols, and Gleyed Ferro-Humic Podzols. Slightly drier soils (Orthic Sombric Brunisols) and wetter soils (Orthic Gleysols) also occur but are of limited areal extent. Gleying is only moderately to weakly expressed, usually as mottles in middle to lower sola. B horizons range from Bm, Bf, Bhf, and Bh (Brunisolics) to podzolic Bf, Bhf, and Bh (Podzolics). The iron, aluminum, and humus enriched B horizons usually develop in the silty veneer overlying glacial material. Gleyed Ferro-Humic Podzols best represent a range of Podzolics which also include Humo-Ferric and Humic Podzols. Bg horizons (Orthic Gleysols) occasionally develop in depressions that are more poorly drained than the more abundant Gleyed subgroups.

Surface organic layers often occur but are very thin and of different character than the thicker fen peat of Lower Subalpine wetlands. Instead, Ah horizons are common, especially under the herb meadow and tundra of SX1. Gleyed and Orthic Sombric Brunisols have Ah horizons >10 cm thick. An illustrative Orthic Ferro-Humic Podzol pedon (Table D28, Plate 51) is from the large SX2 tract at Ottertail Pass and has a slightly coarser textured veneer (Ah through Bf horizons) than usual in SX soils.

Important accessory features are lithic and turbic phases. Lithic phase soils occur where unconsolidated materials are shallow and are more abundant in SX1 than SX2. Turbic phase soils are associated with solifluction and cryoturbation which have disrupted and mixed upper horizons.

Table 125. Definitive features of Sphinx (SX) Ecosites.

Eco-site	Landform	Soils	Vegetation
SX1	Till B; veneer & blanket over inclined, hummocky & ridged bedrock > fluviolacustrine veneer over moraine	Gleyed Dystric Brunisol, Gleyed Ferro-Humic Podzol, Gleyed Sombric Brunisol	moist herb meadow (H16), herb tundra (H17) > low shrub - herb meadow (L7)
SX2	Till B; blanket & veneer over inclined bedrock > fluviolacustrine veneer over moraine	Gleyed Dystric Brunisol, Gleyed Ferro-Humic Podzol	Engelmann spruce-subalpine fir open forest (O9, O14), subalpine larch open forest (O13)

VEGETATION

SX1 is characterized by a complex pattern of herb-rich meadow and tundra vegetation (Plate 52), the predominant v.t.s being fleabane-valerian (H16) and everlasting-grouseberry (H17) with lesser amounts of arctic willow-cinquefoil (L7) on some tracts. Other v.t.s that occur often but have limited areal extent are willow-dwarf birch/fleabane (S4), heather-everlasting (L5) and black alpine sedge-everlasting (H2). S4 and H2 occupy depressions that are wetter than normal and, in H2, experience late snow melt. L5 generally occupies the driest, slightly elevated sites. Small patches of trees, mainly subalpine larch-subalpine fir/heather (O13) are included in some SX1 tracts.

SX2 is characterized by a complex pattern of moist to wet open forest (Plate 53), the predominant v.t.s being Engelmann spruce-subalpine fir/valerian-fleabane (O9), subalpine larch-subalpine fir/heather (O13) and Engelmann spruce-subalpine fir/rock willow/bracted lousewort (O14). O14 is generally restricted to lower elevation and O13 to higher elevation in the Upper Subalpine. The Engelmann spruce-subalpine fir/heather (O10) v.t. also occurs occasionally but only on dry, slightly elevated sites. Forests on nearly 50% of SX2A in upper Tokumm Creek valley have been inhibited by deep accumulations of snow avalanched from the mountain slope to the west.

Vegetation, like the soils, indicates that SX is only marginally wet in that several characteristic v.t.s (*e.g.* H17 and O13) are also common on drier landscapes. Further, stands of these v.t.s on SX are often wetter variants of drier modal concepts. For example, O13 on SX2 frequently has herb-rich understories resembling H16 rather than the drier heath understories of typical O13.

WILDLIFE

SX1 Wildlife Features

Ungulates: Although SX1 is generally of low importance, it is moderately important to elk and mountain goats in summer. Snow depths >1.8 m were recorded in February, which seriously limits winter use.

Carnivores: SX1 is of high importance to martens, wolverines and coyotes year round. The latter two species are probably restricted by soft snow in early winter, but are able to travel freely over the snow pack by February.

Small Mammals: Associations 8, 1 and 5.
The high diversity of small mammals here makes SX1 very highly important. High

Table 126. Wildlife features of SX Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
SX1	low	goat	high	marten wolverine coyote	very high	porcupine marmot Columbian gr. squirrel long-t. vole heather vole	high
SX2	low	elk	medium	weasel	high	porcupine Columbian gr. squirrel heather vole red-b. vole	high

densities of porcupines, hoary marmots, Columbian ground squirrels, long-tailed voles and heather voles occur here.

Breeding Birds: Communities 17 and 18.

A high density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Water Pipit, and Rosy Finch.

SX2 Wildlife Features

Ungulates: SX2 is of moderate importance to elk in summer and of low importance to mule deer and mountain goats. February snow depths >1.8 m were recorded which precludes winter use.

Carnivores: SX2 is moderately important, principally to weasels.

Small Mammals: Associations 6, 5 and 3.

SX2 is highly important chiefly due to a high species diversity. High densities of porcupines, Columbian ground squirrels, heather voles and red-backed voles occur here.

Breeding Birds: Communities 7 and 8.

A high density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Varied Thrush, Chipping Sparrow, Mountain Chickadee, and Yellow-rumped Warbler.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The SX Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and modified slightly to accommodate similar landscape (0.8%) in KNP. Likewise, SX1 (0.4%) and SX2 (0.4%) concepts were used with minor modification in KNP. SX3 used in BNP and JNP for landscape dominated by shrub thicket does not occur in KNP.

SX is the Upper Subalpine counterpart of the Lower Subalpine Consolation Valley (CV) Ecosection, which is wetter than SX due to seepage and high water tables generated by groundwater discharge. SX1, EG4 and JN1 occasionally resemble one another, particularly on aerial photos, but SX1 has characteristics indicative of slightly wetter, seepage-induced conditions.

Imperfect drainage due to seasonal seepage limits most uses. SX may play a role in regulating streamflow and major construction activities may change hydrologic patterns. Locally, steep slopes, irregular topography and solifluction may affect use. Revegetation may be slow after disturbance and removal of vegetation may increase erosion. SX is moderately important overall to wildlife. Heath meadows are highly important to small mammals and migrating and breeding birds. Grizzly bear use is often high in summer and fall.

TK - TEKARRA ECOSECTION

The Tekarra (TK) Ecosection concept incorporates colluvial landforms of noncalcareous, coarse textured (Colluvium A) occurring in the Alpine Ecoregion. Dystric and Sombric Brunisols and Regosols occurring under tundra vegetation are also characteristic. One Ecosite (TK1, Table 127) was differentiated and there are only three tracts of TK1 in KNP. They occur high on prominent ridges, one northwest and two southeast of Vermilion Pass. All are extensions of TK1 tracts in BNP. Fig. 21 illustrates the topographic position of TK1 relative to other Ecosites that are associated with Gog Group quartzitic bedrock.

GEOMORPHOLOGY

TK is geomorphically characterized by colluvial landforms composed of Colluvium A (noncalcareous, coarse textured) occurring as blankets and veneers overlying inclined bedrock, mainly Gog Group quartzite, on steep valley walls. Colluvial veneer plus some exposed bedrock dominate the two TK1X tracts on Storm Mountain. Slopes are 70 to >100%. Colluvial activity, including subtle effects of snow avalanching, varies across the landscape. Sites vary from stable (well vegetated with pedogenic soil development) to very active (often rubbly unvegetated sites in and below steeply sloping couloirs). Intense colluvial activity has resulted in more than the normal proportion (20-50% normally) of unvegetated colluvial rubble on the TK1+CR tract on Boom Mountain. Thin, discontinuous veneers of Eolian material B (altered, medium textured) occur only on the most stable sites, since erosion and colluviation have removed or incorporated most of the eolian material.

SOILS

Soil development and distribution on TK1 reflects variations in kind, intensity, and duration of geomorphic processes. Orthic Regosols occur on recent, intensely active sites in which B horizon development has been inhibited. Soils with B horizons, usually Bm but occasionally thin Bf or Bhf, have formed on comparatively stable sites. Ah horizons usually occur under Alpine tundra and may be thin (Orthic Dystric Brunisols) or thick (Orthic Sombric Brunisols). Weak colluviation such as soil creep may result in physically thickened Ah and B horizons and some Regosolic soils may also have thick Ah horizons (Orthic Humic Regosols). Eluviation, resulting in Ae horizons (Eluviated Dystric Brunisols), has occurred occasionally on the most stable sites. Strong weathering in the presence of Eolian material B on the oldest, most stable sites has resulted in occasional Orthic Humo-Ferric Podzols. Most TK1 soils are well drained.

An Orthic Dystric Brunisol (Table D29) illustrates Brunisolic soils on TK1 and is from the south slope of Eiffel Peak in BNP, about 18 km northwest of Vermilion Pass. The development is typical of stable sites on steep slopes and eolian veneer overlying noncalcareous, coarse textured, colluvial parent material. However, TK1 in KNP has very steep slopes and more than average amounts of sparsely to unvegetated colluvial rubble, conditions under which Regosolics are likely more extensive than Brunisolics. Lithic phases are associated with colluvial veneers and dominate the two TK1X tracts.

VEGETATION

TK1 is characterized by the heather-everlasting (L5) and mountain avens-snow willow-moss campion (H1) v.t.s with L5 more abundant. H1 occurs at higher elevations within the Alpine and is also more common on active slopes. Thus, TK1 in KNP may have substantial if not dominant amounts of H1.

Table 127. Definitive features of Tekarra (TK) Ecosites.

Ecosite	Landform	Soils	Vegetation
TK1	Colluvium A; blanket & veneer inclined bedrock	Orthic Dystric Brunisol, Orthic Sombric Brunisol, Orthic Regosol	heath tundra (L5), avens tundra (H1)

The most active sites are usually either unvegetated or have saxicolous lichen (H12). The TK1+CR tract on Boom Mountain is dominated by sparsely vegetated to unvegetated colluvial rubble interspersed with more stable terrain with H1 and L5.

WILDLIFE

TK1 Wildlife Features

Ungulates: Only three TK1 tracts occur in KNP; one on Boom Mountain and two on Storm Mountain. All are of low importance to ungulates.
Carnivores: TK1 is of low importance.
Small Mammals: Associations 5 and 1.
TK1 is of low importance. Only pikas may occur in high densities.
Breeding Birds: Communities 17 and 18.
A low density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Water Pipit and Rosy Finch.

Table 128. Wildlife features of TK Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	**Overall rank**	**Important species**	**Overall rank**	**Important species**	**Overall rank**	**Important species**	**Overall rank**
TK1	low		low		low	pika	low

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The TK Ecosection concept was developed in the BNP and JNP inventory and applied to identical landscape (0.1%) in KNP. TK is the Alpine counterpart of the Upper Subalpine Endless Chain (EN) Ecosection. Bow Summit (BS) and Redoubt (RD) resemble TK. However, BS occurs on calcareous colluvial materials (Colluvial materials C and D) derived from carbonate and calcareous clastic bedrock and is characterized by more alkaline, often calcareous soils, including Eutric and Melanic Brunisols, and Regosols. RD occurs on finer textured, non- to weakly calcareous, colluvial material (Colluvium B) derived from slaty bedrock. Use is limited by steepness, colluviation and stony surfaces. Removal of vegetation may increase erosion and revegetation will be slow.

VL - VERMILION LAKES ECOSECTION

The Vermilion Lakes (VL) Ecosection incorporates wetland soils and vegetation occurring on fluvial landforms in the Montane Ecoregion. Various water-laid deposits may occur but the prevalent feature is wetness generated primarily by high water tables and surface water collection. Two VL Ecosites (Table 129) were differentiated, primarily by vegetational features. They were mapped on valley bottomland along the Simpson, Vermilion, and Kootenay Rivers and in large benchland depressions where drainage waters have been impounded by glacial landforms, usually producing small lakes and ponds (*e.g.* Dog Lake) bordered by fen. Most VL terrain occurs where surface water drainage has been impeded, usually by downstream and surrounding landforms. Fig. 18 illustrates the topographic relationships among VL6 and several other Ecosites, although several large VL6 tracts extend across the bottomland replacing the Fireside 3 (FR3) and Hillsdale 6 (HD6) positions.

Table 129. Definitive features of Vermilion Lakes (VL) Ecosites.

Ecosite	Landform	Soils	Vegetation
VL2	Fluviolacustrine material B & Fluvial material B; level > horizontal fen	Rego Gleysol > Terric Mesisol	wet shrubby meadow (S1)
VL6	Fluvial material B; level > horizontal fen	Rego Gleysol, Gleyed Regosol > Terric Mesisol	wet spruce open forest (O11)

GEOMORPHOLOGY

Fluvial material B (calcareous, coarse-stratified) and Fluviolacustrine material B (calcareous, fine-stratified) are the characteristic constituents of VL landforms. The fluviolacustrine material occurs most often as weakly stratified layers extending to the mineral surface or less often as subsurface layers interbedded with the coarser textured fluvial material. Surface layers of fluviolacustrine sediment are thickest and most abundant in VL2. Glaciofluvial material B (calcareous, coarse textured) usually underlies the fluviolacustrine and fluvial sediments, but only on floodplains in valley bottomlands along major streams. The sampled pedon (Table D30), from a VL2 tract near Kootenay Crossing, typifies the genetic material sequence that reflects changing depositional environments. Deepest is glaciofluvial material which, by its textural characteristics, indicates deposition by high energy, unrestricted stream flow. Textures become finer upwards and reflect a change to low energy fluvial deposition as stream flow became increasingly more restricted. Incorporation of humus in upper mineral layers indicates that organic layers developed as sedimentation diminished. Finally, peat layers, developed since virtual cessation of sediment deposition, mantle the mineral soil.

Thickness of peat in VL soils ranges from zero, where mineral accretion is still active, to >1 m, but rarely exceeds 1.2 m. Horizontal fen occurs where the peat is >40 cm thick and is the subdominant landform on most VL2 and VL6 tracts but may be virtually absent on others. The peat is predominantly mesic (moderately decomposed) but fibric and humic layers and wood fragments also occur.

Landform surface expression for both VL Ecosites is predominantly level floodplain although VL6 includes some subtly terraced terrain. Slopes are generally 0 to 2% but occasionally are up to 5%. Slope continuity on VL6 is often broken by stream channels (Eroded modifier, C.S.S.C. 1978a), including narrow, elevated ridges along the banks.

SOILS

VL is characterized by imperfectly to very poorly drained soils of the Regosolic, Gleysolic, and Organic Orders. Both VL Ecosites are characterized by a soil pattern in which gleyed mineral soils are dominant and Organics are subdominant (Table 129). VL2 has a narrower range of soils and drainage (poor to very poor) than VL6 (imperfect to very poor). The combination of wetness and mineral accretion has precluded pedogenic horizonation in most VL soils. Gleization is variable and depends on water table fluctuations and duration of saturation. Rego Gleysols are more strongly gleyed than Gleyed Regosols and reflect longer saturation periods. Sedimentation appears to have been frequent and continuous during accretion of mineral layers although *cumulic* profiles (*e.g.* Gleyed Cumulic Regosols) generated by intermittent deposition also occur as accessory soils.

VL mineral soils may be thinly mantled by organic layers, as in the example pedon (Table D30, Plate 54), or lack surficial peat where mineral accretion precludes organic layer development. Horizontal fen (>40 cm of peat) and associated Organic soils, mainly Terric Mesisols, are subdominant on most VL2 and VL6 tracts but may be virtually absent on others. Fen vegetation occurring under conditions of very poor drainage and long absence of sedimentation has built up thick peat deposits. A few imperfectly drained mineral soils have escaped mineral deposition long enough for B horizons, mainly Bm, to develop. Thus, Gleyed Eutric Brunisols are among the accessory soils of VL6.

VEGETATION

VL2 and VL6 have distinctly different vegetation. VL2 is characterized by shrubby meadow, mainly the dwarf birch-shrubby cinquefoil-willow/brown moss (S1) v.t. (Plate 55). Accessory v.t.s are spruce/Labrador tea/brown moss (O11) and water sedge-beaked sedge (H11). Both occur as small patches; O11 along tract margins and H11 on the wettest, usually ponded sites.

VL6 is characterized by spruce open forest, mainly the spruce/Labrador tea/brown moss (O11) v.t. There are several localities, however, where O11 grades to closed forest v.t.s similar to lodgepole pine/feathermoss (C11, north of Kootenay Crossing), Engelmann spruce-subalpine fir/feathermoss (C13, south of Vermilion Crossing), and white spruce-subalpine fir/bunchberry-horsetail (C41, along most channels, Plate 56). Another accessory v.t., Engelmann spruce-subalpine fir/willow/ribbed bog moss (O6), resembles O11. White spruce/buffaloberry/feathermoss (C37) occurs sporadically on the drier parts of VL6. Intergrades among the v.t.s are common.

WILDLIFE

VL2 Wildlife Features

Ungulates: Complexes of wet shrub meadow (S1), sedge fen (H11), and open spruce forest (O11) are highly important to elk and moose, especially in winter. VL2 in association with wetlands (Dog Lake and Daer Pond) and man-made grasslands (Dolly Varden Meadows and Kootenay Crossing) is very highly important to wintering elk. Ungulate use of forage is high on willows (***Salix glauca***, ***Salix*** spp.) and dwarf birch (***Betula glandulosa***) in S1 and O11 and on willows and sedges (***Carex*** spp.) in H11.

Carnivores: VL2 is highly important, particularly to coyotes and cougars, in winter. During the winter of 1982-83 wolves made frequent use of VL2 at Dolly Varden Meadows and Daer Pond.

Small Mammals: Association 4.
VL2 is highly important to meadow voles, masked shrews and beavers.

Breeding Birds: Community 6.
A high density of birds was recorded. Species diversity is medium. Based on density

Table 130. Wildlife features of VL Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
VL2	high	moose elk	high	coyote cougar	high	beaver meadow vole	high
VL6	high	moose elk	high	coyote marten cougar	medium	red-b. vole meadow vole	high

indices derived from circular census plots, this Ecosite is highly important to Western Wood Pewee, Common Yellowthroat, Barn Swallow, Brown-headed Cowbird, and Willow Flycatcher. This is the only site where Osprey occur.

VL6 Wildlife Features

Ungulates: VL6 is highly important year round, especially for elk and moose in winter. Use is highest where associated with Highway 93 grasslands and HD6.

Carnivores: VL6 is highly important to coyotes and martens year round, and moderately important to most other carnivores. Historical records indicate that VL6 in the Kootenay Crossing area may be highly important to cougars in winter and spring.

Small Mammals: Associations 3 and 4.
A moderate number of species occurs here at moderate to high densities. Red-backed voles, meadow voles, dusky shrews and masked shrews occur at high densities. VL6 is highly important to beavers.

Breeding Birds: Communities 5, 6 and 20.
A high density of birds was recorded. Species diversity is high. Based on density indices derived from circular census plots, this Ecosite is highly important to Cedar Waxwing, Yellow Warbler, Warbling Vireo, Swainson's Thrush, American Robin, Yellow-rumped Warbler, Ruffed Grouse, Hammond's Flycatcher, and Hairy Woodpecker.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The VL Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and applied to similar landscape (0.8%) in KNP. However, two new Ecosites, VL2 (0.2%) and VL6 (0.6%) were defined to better accommodate soil and vegetational features in KNP. Four other VL Ecosites used to map BNP and JNP landscapes were not used because similar landscapes in KNP are unmappable or virtually nonexistent.

VL is the Montane counterpart of the Lower Subalpine Hector (HC) Ecosection. Wetland of the compound Ecosites Daer 6 and Daer 8 resemble VL but are too small to map as such. Hillsdale 3 (HD3) and Fireside 3 (FR3) may resemble VL6 but HD3 and FR3 are characterized by drier soils and closed forests.

Imperfect to very poor drainage, due to high water tables and flooding, severely limits most uses. Also, fluvial deposition occurs on some tracts. Major construction activities may change hydrologic patterns. VL is very important to wildlife. It provides critical ungulate range and contains high small mammal populations which support many carnivore species. Numerous birds species occur in high densities and some are unique to these wetlands. VL is very important to amphibians especially as a breeding site.

WF - WILDFLOWER ECOSECTION

The Wildflower (WF) Ecosection concept incorporates: landforms composed predominantly of calcareous colluvium, well drained Brunisolic and Regosolic soils, and Upper Subalpine vegetation including both open and closed coniferous forests and avalanched communities. Five WF Ecosites (Table 131) are recognized.

WF occupies middle to upper elevation, steep valley walls throughout KNP, usually in close association with calcareous bedrock. This position makes it likely that WF landscapes are post-glacial. Figs. 13 and 22 illustrate topographic relationships among some WF and other Ecosites.

GEOMORPHOLOGY

The predominant genetic material characterizing the WF Ecosection is Colluvium C (calcareous, medium textured). WF1 and WF2 are restricted to consistently calcareous areas of the Main Ranges and are usually underlain by resistant carbonate bedrock. Colluvium C is thus by far predominant in these two Ecosites.

WF5 and WF6, occurring in the lithologically intricate Western Ranges (Fig. 2), are also dominated by calcareous colluvium but include Colluvium D (calcareous, fine textured) in addition to Colluvium C. A third material, Colluvium B (non- to weakly calcareous, medium textured), is locally important and of sufficient areal extent to be the subdominant genetic material unit. Minor amounts of Colluvium A (noncalcareous, coarse textured) are also present in some WF5 and WF6 tracts. Intergrades among the four colluvial materials also occur. The colluvium in WF5 often overlies a veneer of weathered bedrock if the bedrock is inherently soft. This veneer may be Residuum A, B or C depending on the bedrock calcareousness and texture and there is often a correspondence between the characteristics of the residuum and the overlying colluvium. Textures of both are usually medium to fine.

WF3 is the only WF Ecosite that spans the park, transcending geological subprovince boundaries. Colluvium C is the principal genetic material, even in the Western Ranges, because WF3 usually occurs as a pattern of shallow colluvium plus bedrock outcrops on steep, rugged, bench and cliff topography. Resistant carbonate bedrock rather than softer slate or calcareous shale, is most often expressed in this way and the colluvium reflects the carbonate bedrock origin.

The colluvium in WF occurs most frequently as uniform blankets or veneers, the thinner of which only subtly mask the underlying bedrock. WF3, however, is characterized by discontinuous colluvial veneers plus bedrock outcrops. WF2 and WF6 sometimes include colluvial aprons in addition to the blankets and veneers. Aprons in WF2 and WF6 are frequently a series of coalescing colluvial cones that have developed below steep rock walls. Couloirs in the rock wall channel avalanches, springtime meltwater, and occasional mudflows onto the cones. Thus, the aprons are often a mixture of intercalated colluvial, fluvial, and mudflow materials. Stability of the mineral surface varies considerably in WF2 and WF6 and depends on the amount of debris eroded or deposited. Generally, couloirs and the fan-shaped localities below them are the most active. Small fluvial and mudflow cones occur at the base of forested WF colluvial slopes.

Long, straight inclines are typical of most WF landscapes. Slopes may be 45 to >100%, although slopes <55% are not extensive. WF3, with cliff and bench topography, has less uniform slopes that frequently average >70%.

Table 131. Definitive features of Wildflower (WF) Ecosites.

Eco-site	Landform	Soils	Vegetation
WF1	Colluvium C; blanket & veneer over inclined bedrock	Orthic & Eluviated Eutric Brunisols, Orthic Regosol	Engelmann spruce-subalpine fir forest (C21 $>$ C15)
WF2	Colluvium C; blanket & veneer over inclined bedrock, apron; avalanched	Orthic Eutric Brunisol, Orthic Regosol, Orthic & Cumulic Humic Regosols	Avalanche complex 2 $>$ Engelmann spruce-subalpine fir forest (C21)
WF3	Colluvium C; veneer over inclined bedrock + exposed bedrock	Lithic phases: Orthic Eutric Brunisol, Orthic Regosol, Orthic Humic Regosol; + nonsoil	mixed coniferous open forest (O4)
WF5	Colluvium C & D $>$ B; veneer & blanket over inclined bedrock	Orthic Eutric Brunisol $>$ Orthic Dystric Brunisol, Eluviated Eutric Brunisol	Engelmann spruce-subalpine fir forest (C15)
WF6	Colluvium C & D $>$ B; blanket & veneer over inclined bedrock, apron; avalanched	Orthic Eutric Brunisol, Orthic & Cumulic Humic Regosols $>$ Orthic Dystric Brunisol	Avalanche complex 2 $>$ Engelmann spruce-subalpine fir forest (C15)

In general, the steeper the slope, the broader the area that adjusts to restabilize the slope after minor disturbances such as the uprooting of trees. Steep southerly aspects are often dry and may have mineral soil exposed to erosion. The tendency towards surface instability in colluvium is heightened by its loose packing. Thus, intact surficial veneers of eolian material are absent in WF, except for rare occurrences in the most stable localities.

WF2 and WF6 characteristically have $>50\%$ of the area affected by snow avalanching. Avalanching occasionally influences up to 20% of any WF tract. If between 20 and 50% is avalanched, A is included with the map symbol. Many WF3 tracts, especially in the Main Ranges, are partially modified by avalanching as indicated by the modifier A included parenthetically in the legend.

SOILS

Most WF soils are moderately well to rapidly drained Brunisolics or Regosolics. The predominant soils are Orthic Eutric Brunisols (Table 131) which occur on a majority of the calcareous colluvium where stability has been sufficient for soil development (≥ 1000 years). Most of these Orthic Eutric Brunisols have little or no A horizon development, B horizons that are weakly to moderately developed (little extractable iron, aluminum, and humus) and 5 to 30 cm thick, and moderately to extremely calcareous C horizons. The lower sola are medium acid to mildly alkaline (pH >5.5). The other characteristic soils are interspersed with and are usually closely related to the Orthic Eutric Brunisols.

Eluvial (Ae) horizons are often present on the most strongly weathered, most stable Eutric Brunisols. If the Ae is ≥ 2 cm thick, the profile is an Eluviated Eutric Brunisol. In the Main Ranges, these strongly expressed soils are codominant with Orthic Eutric Brunisols and Orthic Regosols in WF1 and are accessory soils in the subdominant forested portions of the WF2. In the Western Ranges on WF5, Eluviated Eutric Brunisols constitute a subdominant member of the soil pattern. Eluviation here may reflect the low-lime, readily weathered parent material as much as a rigorous weathering regime.

Orthic Dystric Brunisols are the other subdominant member of WF5 and WF6. These soils develop on stable to moderately active sites where the parent material is inherently low in lime or is lime-free. B horizons are strongly to very strongly acid (pH 4.5-5.5). Related Eluviated Dystric Brunisols (Ae horizon ≥2 cm) are accessory soils in WF5.

On highly calcareous colluvium, geomorphic disturbance often severely retards soil development by exposing or incorporating fresh calcareous material in the solum, resulting in Regosolic soils. Orthic Regosols, with little or no A or B horizon development, are one group of codominant soils that characterize WF1, 2, 3 and 6. Orthic Humic Regosols of WF2, 3 and 6 probably result from surface disturbance that mechanically incorporates organic material into the topmost 10 cm (or more) of mineral material, creating an Ah horizon. Fresh mineral material is often deposited on avalanched colluvial slopes, especially below couloirs. The activity often buries organic-rich layers, creating the accessory Cumulic Regosols (Ah <10 cm) and codominant Cumulic Humic Regosols (Ah ≥10 cm) of WF2 and WF6.

Infrequently, surface colluviation mechanically incorporates humus into the topmost 10 cm (or more) of Brunisolic soils. The resultant Orthic Melanic Brunisols are accessory in WF2 and WF3.

Colluvium often is shallow, especially on steep slopes, and while lithic phases occur sporadically in any WF Ecosite, they are characteristic of WF3 soils and other WF tracts with the modifier **X**. Numerous nonsoil areas are interspersed with the lithic soils in WF3, since bedrock crops out or is mantled by <10 cm of overburden over much of WF3.

Turbic phase soils also may occur on any WF Ecosite and are accessory characteristics of WF5 and WF6. Tree blowdown is probably the most common cause of soil disruption on forested slopes. Avalanching may uproot vegetation (WF2, WF6), while intense colluviation on steep, unstable slopes disturbs upper horizons.

A pedon illustrating WF soils (Table D31, Plate 57) is from a WF3 tract above Pitts Creek and has features typical of soils in steep, craggy terrain controlled by carbonate bedrock. The pedon is lithic phase and the colluvium is extremely calcareous. Active colluviation on the 80% slope has mechanically incorporated both organic material and fresh carbonate into the upper solum. Although the Bmk has sufficient organic carbon for a Bh horizon, it was not labelled Bh because color value and chroma are too high (C.S.S.C. 1978a). Further, the environment is incorrect for a Humic Podzol. The profile is closely related in morphology to Orthic Regosol, Orthic Humic Regosol, and Orthic Melanic Brunisol, the differences being only in degree of Bm horizon development and thickness of Ah.

VEGETATION

The vegetation groups that typify each WF Ecosite (Table 131) reflect differences in exposure and geomorphic activity. Closed forests tend to develop on slopes that have been stable longest. In the Main Ranges on WF1, the Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) v.t. occurs in a pattern with a lesser percentage of Engelmann spruce-subalpine fir/grouseberry (C15), while C15 is the predominant v.t. on the Western Range WF5 (Plate 58). C21 is an accessory v.t. on WF5, as is Engelmann spruce-subalpine fir/heather (O10). Both WF1 and WF5 have the subalpine larch-subalpine fir/grouseberry-everlasting (C23) v.t. as an accessory.

The steepness and ruggedness of WF3 is reflected in the vegetation. The Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4) v.t. (Plate 59) is predominant, with Engelmann spruce-subalpine fir/heather (O10) and subalpine larch-subalpine fir/heather (O13) as accessories. Unvegetated areas (<20% cover) are another common feature of WF3, usually associated with steep bedrock outcrops.

Avalanched portions of WF2 (Main Ranges) and WF6 (Western Ranges) contain a v.t. complex designated as Avalanche complex 2. Avalanche complex 2 consists of subalpine fir-willow (S2), hairy wild rye-wild strawberry-fireweed (H5), fleabane-valerian (H16), and fireweed-meadow rue (H22), plus intergrades. S2 is most abundant. Forested strips (<50%) between avalanche paths are usually Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) on WF2 and Engelmann spruce-subalpine fir/grouseberry (C15) on WF6. Accessory v.t.s on WF2 are C15 and Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4). On WF6 they are C21, Engelmann spruce-subalpine fir/heather (O10), and subalpine larch-subalpine fir/heather (O13). Unvegetated areas occur occasionally on the geomorphically most active sites on both Ecosites, such as on talus cones or channels below couloirs.

WILDLIFE

WF1 Wildlife Features

Ungulates: WF1 is of low importance overall although moderately important to moose, especially in summer. Winter use is precluded by deep snow. Summer use is mostly associated with avalanched tracts.

Carnivores: The importance of WF1 is low, except to martens which occur at high densities.

Small Mammals: Associations 3 and 4.
A high number of species occurs at low to moderate densities. High densities of red-backed voles and heather voles can occur here.

Breeding Birds: Communities 7 and 8.
A low density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Ruby-crowned Kinglet and Pine Grosbeak.

WF2 Wildlife Features

Ungulates: WF2 is highly important, most notably to mountain goats. Highest use of WF2 by mountain goats was associated with the tract on Mount Wardle, although moderate goat use was recorded on other WF2 tracts. Ungulate use is restricted to summer and fall owing to high snow accumulations.

Carnivores: WF2 is highly important to wolverines and of moderate importance to coyotes and cougars.

Small Mammals: Associations 8 and 3.
This avalanched Ecosite supports a large number of species at moderate densities. Only Columbian ground squirrels occur at high density. Pikas, hoary marmots and golden-mantled ground squirrels occur in moderate numbers.

Breeding Birds: Communities 7 and 8.
A medium density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Chipping Sparrow.

WF3 Wildlife Features

Ungulates: WF3 is very highly important, especially to mountain goats and bighorn sheep. It is very highly important to bighorn sheep during summer and fall in the Kindersley-Sinclair areas of southwestern KNP. Summer use by bighorn sheep was also recorded on WF3 in upper Pitts Creek on the Mitchell Range. Importance to mountain goats is high year round throughout KNP, particularly on south-facing wind-blown tracts where snow accumulation is low. WF3 is also of high importance to mule deer in summer and fall, particularly in the Sinclair and Stoddart drainages.

Carnivores: WF3 is very highly important to cougars in summer and fall because of the high use by mule deer and bighorn sheep. It is of low to moderate importance to other carnivores.

Table 132. Wildlife features of WF Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
WF1	low		low	marten	medium	red-b. vole heather vole	low
WF2	high	goat	medium	wolverine	high	Columbian gr. squirrel pika	medium
WF3	very high	goat sheep	medium	cougar	medium	deer mouse least chipmunk	high
WF5	medium	mule deer	medium	marten cougar	low	hare	low
WF6	high	goat elk	medium	cougar	high	pika Columbian gr. squirrel	low

Small Mammals: Associations 1, 3 and 5.
A moderate number of species occurs at low to moderate densities. Deer mice and least chipmunks can occur at high densities.

Breeding Birds: Community 7.
A high density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Ruby-crowned Kinglet, Rufous Hummingbird, White-crowned Sparrow, Pine Grosbeak, Red-breasted Nuthatch, and Evening Grosbeak.

WF5 Wildlife Features

Ungulates: WF5 is of moderate importance overall, although of high importance to mule deer in summer in the Kindersley-Sinclair area. Moderate summer use is made by bighorn sheep in upper Sinclair Creek. High snow accumulations preclude winter use.

Carnivores: WF5 is moderately important especially to martens, cougars and lynx.

Small Mammals: Associations 3 and 6.
A low number of species occurs here at low densities. Only snowshoe hares occur at high density.

Breeding Birds: Communities 7 and 8.
A low density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Golden-crowned Kinglet, and Yellow-rumped Warbler.

WF6 Wildlife Features

Ungulates: WF6 is of high importance to mountain goats all year and to elk in summer. Most summer elk use occurs on avalanche paths with S2, H5 and H16 v.t.s. Summer goat use is high on avalanche shrub types and O10, while winter use is high only on O10.

Carnivores: WF6 is highly important to cougars, but of low to moderate importance to other carnivores.

Small Mammals: Associations 8, 3 and 5.
This avalanched Ecosite supports a high number of species at moderate to high densities. High numbers of pikas, Columbian ground squirrels, red-backed voles and heather voles occur here.

Breeding Birds: Communities 7 and 8.
A low density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Golden-crowned Kinglet and Yellow-rumped Warbler.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The WF Ecosection concept originated in the BNP and JNP inventory (Walker *et al.* 1982d) and has been slightly modified for KNP. WF5 and WF6 were added for KNP because of the range of textures and calcareousness in the Western Ranges and the accompanying diversity in vegetation and, especially, soils.

WF accounts for 6.2% of KNP. Sawback (SB) is the Lower Subalpine counterpart of WF, while Bow Summit (BS) is the Alpine counterpart, since all three occur on predominantly calcareous colluvium. WF most closely resembles the Whitehorn (WH) Ecosection but the latter, while Upper Subalpine, occurs on noncalcareous rather than calcareous colluvium and has predominantly acidic soils. WF1 (0.4%) and WF5 (1.2%) correspond to WH6 (spruce-fir), WF2 (0.8%) and WF6 (1.0%) to WH7 (avalanched), and WF3 (3.0%) to WH4 (steep, lithic). The Upper Subalpine Endless Chain (EN) Ecosection is less closely related to WF because the colluvium in EN is noncalcareous and coarse textured.

Steepness and colluviation are major limitations. The Ecosites from most to least active are: WF2 and WF6 (avalanched), WF3 (craggy), and the others (forested). Removal of vegetation may increase erosion. WF is highly important to mountain goats year round and bighorn sheep in summer.

WH - WHITEHORN ECOSECTION

The Whitehorn (WH) Ecosection concept incorporates: Upper Subalpine vegetation on colluvial landforms of non- to weakly calcareous, medium textured colluvium (Colluvium B). Dystric Brunisols are characteristic although Regosols are abundant in some WH landscapes. Five WH Ecosites (Table 133) differ in vegetation and soil patterns relative to kind, intensity, and duration of colluvial processes. WH occurs high on valley walls in the western Main Ranges. Fig. 23 illustrates topographic relationships among the WH Ecosites and related landscapes.

GEOMORPHOLOGY

WH is geomorphically characterized by colluvial landforms composed of Colluvium B (non- to weakly calcareous, medium textured). Most WH is in the western Main Ranges, east of the Vermilion/Mitchell ranges, where the colluvium is derived from Chancellor Formation slate. Several tracts occur west of the Vermilion/Mitchell ranges on McKay Group bedrock. Whether McKay Group or Chancellor Formation, the slaty bedrock is recessive and the topography is subdued, albeit steep. The top of the recessive bedrock is occasionally weathered, remaining *in situ* as a veneer of Residuum A (non- to weakly calcareous, medium textured) which occurs between the colluvium and consolidated bedrock. Residuum is occasionally exposed on gentler slopes. Colluvium C (calcareous, medium textured) occurs locally in association with limestone layers within the slaty strata. Discrete veneers of Eolian material B (altered, medium textured) are rare in WH. If present, eolian material is usually mixed with colluvium in upper soil horizons.

Colluvium occurs most often as veneers and blankets reflecting steeply inclined bedrock on valley walls. The modifier X, meaning lithic phase soils are dominant, can be applied to any WH Ecosite (*e.g.* WH7X in Misko Creek valley) except WH4 and indicates that colluvial veneer is the dominant landform. Discontinuous colluvial veneer with lithic phase soils and exposed bedrock are the norm in WH4. Deep colluvial aprons occur in some valleys as the lower slopes between valley floor and wall. They are usually constructed by snow avalanching and rockfall below very steep rocky slopes. Numerous shallow couloirs, cut into the steep rocky slopes, channel intermittent streams and mudflows onto the aprons. Thus, the aprons are often a mixture of intercalated colluvial, fluvial, and mudflow deposits.

Fig. 23. Landscape schematic of topographic relationships among WH, FV and RD Ecosites.

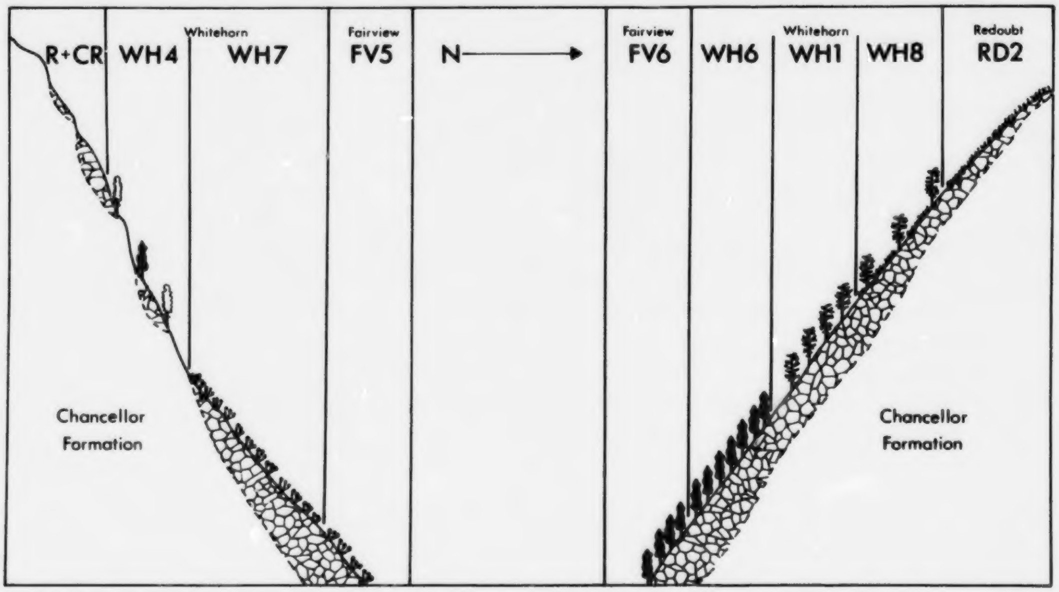


Table 133. Definitive features of Whitehorn (WH) Ecosites.

Ecosite	Landform	Soils	Vegetation
WH1	Colluvium B; veneer & blanket over inclined bedrock	Eluviated Dystric Brunisol	subalpine larch-subalpine fir forest (C23)
WH4	Colluvium B; veneer over inclined bedrock + exposed bedrock	Lithic phases: Orthic Dystric Brunisol > Orthic Regosol, Orthic Eutric Brunisol; + nonsoil	mixed coniferous open forest (O4) > subalpine larch open forest (O13)
WH6	Colluvium B; veneer & blanket over inclined bedrock	Eluviated Dystric Brunisol > Orthic Dystric Brunisol, Orthic Eutric Brunisol	Engelmann spruce-subalpine fir forest (C21 > C15)
WH7	Colluvium B; blanket & veneer over inclined bedrock, apron; avalanched	Orthic Dystric Brunisol, Orthic Regosol, Cumulic Regosol > Orthic Eutric Brunisol, Orthic Humo-Ferric Podzol	Avalanche complex 2 > Engelmann spruce-subalpine fir forest (C21), subalpine larch-subalpine fir forest (C23)
WH8	Colluvium B; veneer & blanket over inclined bedrock; soliflucted	Turbic phases: Orthic Dystric Brunisol > Orthic Sombric Brunisol, Orthic Eutric Brunisol	herb meadow (H16), herb tundra (H17) > subalpine larch open forest (O13)

Slopes are usually long, straight and 45 to >100%, although slopes <55% are not extensive. WH1 and WH8 have the gentlest slopes, seldom >70%. WH4 has the steepest (rarely <60%), most irregular slopes, although cliff and bench topography is not as well expressed on the recessive bedrock as on limestone (WF3) or quartzite (EN3). Except for bedrock prominences on some WH4 tracts, exposed bedrock usually blends into the overall slope and massive, precipitous cliffs are uncommon. A few WH tracts, with complex slopes, straddle ridge tops and include a variety of topographic positions and slopes. Tracts with the modifier F (*e.g.* WH1F near Mount Haffner) have a subdued, hummocky to ridged, bench-like topography superimposed on an inclined slope. This subtly irregular topography is produced by partial failure of the bedrock. Tension cracks and short slip scars are often evident, particularly where the overburden is shallow.

Present colluvial activity is variable within and among WH Ecosites. Uniform, well established vegetation indicates that landform construction has virtually ceased in WH1, WH6, and WH8. Here the current geomorphic processes are of low intensity, modifying only near-surface materials. These processes include uprooting of trees, soil creep, and solifluction, and result in mixed or disrupted upper sola horizons. Manifestations of solifluction are particularly widespread in WH8 soils.

Colluvial activity is more diverse with variation in kind and intensity on terrain characterized by snow avalanching (WH7) and rugged rocky slopes (WH4). Depositional and erosional processes here include rockfall, avalanching, fluvial and mudflow activity, slope wash, and soil creep. Modifying processes include uprooting of trees, soil creep, and solifluction. Thus, sites vary from those that are comparatively stable (well vegetated with pedogenic soil development) to very active, often rubbly, unvegetated sites. Colluvial activity that is both intensive and extensive has resulted in more than the normal proportion (20-50% normally) of unvegetated colluvial rubble on the few tracts mapped as WH7+CR (*e.g.* Honeymoon Pass).

While avalanching is widespread (>50%) and characteristic of WH7, it may affect up to 20% of other WH tracts. For example, channeled paths are common but of small areal extent on WH4 because they are confined to its poorly incised couloirs. Avalanching is more extensive (20-50%) on WH4A. Forested tracts whose identifying symbol includes the modifier A may also have 20 to 50% of this area affected by avalanching (*e.g.* WH1A). Avalanching is likely common on WH8 but the effects are only subtly expressed on the herbaceous, near-Alpine vegetation.

SOILS

Soils of WH are rapidly to moderately well drained. Their distribution and development reflects variations in kind, intensity, and duration of geomorphic processes. Brunisolic soils are associated with sites where geomorphic activity is of low intensity or has ceased, provided there has been sufficient time for B horizon development. Dystric Brunisols characterize WH and are dominant or codominant for each Ecosite (Table 133). These soils commonly have moderately to well developed Bm horizons and strongly to extremely acidic (pH <5.5) lower sola. They may have either weakly to moderately developed Ae horizons (Eluviated Dystric Brunisols), most abundant under closed forest, or minimal to no Ae horizon development (Orthic Dystric Brunisols) which indicates low intensity surficial activity.

Orthic Eutric Brunisols, among the subdominant soils of all but WH1, are similar to Orthic Dystric Brunisols but have medium acid to neutral (pH ≥5.5) lower sola. They are developed in weakly calcareous colluvium where weathering has been insufficient to acidify the sola, likely because minor activity continues or stability has been of short duration. The sampled pedon (Table D32, Plate 60), from the WH4 tract above Numa Creek, typifies more alkaline WH soils and has chemical characteristics very near the taxonomic boundary with Orthic Dystric Brunisols. Eluviated Eutric Brunisols, similar to Eluviated Dystric Brunisols except in pH, also occur as accessory soils in WH6.

Orthic Dystric Brunisols may have thin Ah or Ahe horizons, most often developed at high elevations under subalpine larch and herbaceous vegetation. A closely related goup, Orthic Sombric Brunisols, have thick (>10 cm) Ah horizons with minimal eluviation. These are among the subdominant soils of WH8 but also occur as accessory soils on the avalanched WH7. The thick Ah horizons were likely produced by mechanical incorporation of humus in the uppermost mineral materials.

Orthic Humo-Ferric Podzols, also closely related to Orthic and Eluviated Dystric Brunisols, occur occasionally on WH. They are accessory soils in WH1, WH6, and WH8 and represent the strongest development in the most stable sites, usually occurring where Eolian material B is a significant constituent of upper sola. Orthic Humo-Ferric Podzols are among the subdominant soils of WH7 and occur where humus and mineral material conducive to strong development were mechanically incorporated into middle sola. Subsequent stabilization, even though avalanching still affects the vegetation, has allowed normal pedogenic processes to operate. The products include some unusual Podzolic soils like the base-rich pedon (Table D17) from a Fairview 5 (FV5) tract, which is the Lower Subalpine counterpart of WH7. Orthic Ferro-Humic Podzols may also occur occasionally in the complex geomorphic-pedogenic environments of avalanche slopes.

In contrast to the comparatively stable Brunisolic and Podzolic soils, Regosolic soils occur at sites that are or have recently been intensely active so that B horizon development has been inhibited. They are codominant on WH7, subdominant on WH4, and occur in minor amounts on other WH Ecosites. Various Regosolic groups occur, particularly on avalanched terrain. Orthic Regosols, with low but uniform organic matter content throughout the profile, are associated with intense erosion and frequent, humus-poor, mineral deposition. Others have mechanically mixed, and buried, humus-rich layers within the profiles (Cumulic Regosols), sometimes with thick (>10 cm), mechanically mixed Ah horizons at the mineral surface (Cumulic Humic Regosols). The latter two groups occur only on avalanche paths and are most abundant on colluvial aprons where deposition is greatest and tends to be episodic. Regosolic soils likely dominate tracts of WH7+CR. The variety of Brunisolic, Regosolic, and Podzolic soils on WH7 demonstrates the diverse and complex interactions of geomorphic activity and pedogenic weathering on avalanched terrain, likely the most complex in KNP.

The colluvium is often a shallow veneer, especially on steep slopes and, while lithic phase soils are common in any WH Ecosite, they are characteristic of WH4. Nonsoil areas are also extensive (up to 80%) on WH4, occurring as exposed bedrock or as <10 cm of overburden. Turbic phase soils may also occur on any WH Ecosite but are accessory features of WH1 and WH6 and characteristic of WH8. Turbic manifestations include mixed, contorted, displaced, or disrupted horizons, as in the turbic phase pedon (Table D33) from a WH8 tract above Goodsir Pass. Disturbance is most often by solifluction, less often by soil creep and tree throw.

VEGETATION

The v.t.s that typify each WH Ecosite (Table 133) reflect differences in elevation and geomorphic activity. Closed forests develop on stable, low elevation (within the Upper Subalpine) slopes. WH1 is dominated by the subalpine larch-subalpine fir/grouseberry-everlasting (C23) v.t. (Plate 61) which grades to narrow bands of subalpine larch-subalpine fir/heather (O13) along the upper elevational limits of the Ecosite. WH6 occurs below WH1 and is characterized by Engelmann spruce-subalpine fir forest with Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) dominant (Plate 62) and Engelmann spruce-subalpine fir/grouseberry (C15) subdominant. The two groups overlap giving small Engelmann spruce-subalpine fir stands in WH1 subalpine larch forest and small subalpine larch stands in WH6 Engelmann spruce-subalpine fir forest.

WH8 is also stable and well vegetated, the main geomorphic process being low intensity solifluction that has modified upper soil horizons. This Ecosite occurs on southerly aspects at high elevations transitional to Alpine. It is characterized by a v.t. pattern in which fleabane-valerian (H16) and everlasting-grouseberry (H17) are more abundant than subalpine larch-subalpine fir/heather (O13). Subalpine larch in O13 usually occurs as scattered trees or, less often, as krummholz on exposed or infrequently avalanched sites. Krummholz subalpine fir also occurs sporadically and the heather-everlasting (L5) v.t. (an accessory feature) occasionally replaces H16 or H17.

The steepness and ruggedness of WH4, occurring on all aspects and at all elevations within the Upper Subalpine, is reflected in the vegetation (Plate 63). WH4 is characterized by a v.t. pattern in which Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4) is dominant and subalpine larch-subalpine fir/heather (O13) is subdominant. O4 is prevalent on subxeric, exposed sites, particularly on southerly aspects and at lower elevations within the Upper Subalpine. O13 is most common on mesic sites and at higher elevations (>2100 m). A variety of low shrub and shrub v.t.s, such as subalpine fir-willow (S2) on avalanched portions, may also occur in minor amounts. Unvegetated or sparsely vegetated terrain is associated with active erosion or colluviation, such as in frequently avalanched couloirs, and with large, bedrock exposures. Such localities, interspersed with vegetated areas, may constitute up to 50% of some WH4 tracts.

The geomorphic-soil diversity of avalanched terrain also applies to vegetation. Avalanched segments dominate WH7 and are characterized by a heterogeneous complex of v.t.s, termed *Avalanche complex 2*, that includes subalpine fir-willow (S2), hairy wild rye-wild strawberry-fireweed (H5), fleabane-valerian (H16) and fireweed-meadow rue (H22), plus intergrades and other heterogeneous assemblages. S2 and H16 are most abundant on the majority of avalanche paths. Forested portions, unaffected by avalanching, usually constitute much less than 50% of WH7. They fringe avalanche runout zones and form strips between avalanche paths. The most common forest v.t.s are Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) and subalpine larch-subalpine fir/grouseberry-everlasting (C23), although Engelmann spruce-subalpine fir/grouseberry (C15), Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4) and subalpine larch-subalpine fir/heather (O13) also occur occasionally as accessory v.t.s. The geomorphically most active sites, such as talus cones and channels below couloirs, are usually unvegetated or sparsely vegetated. Unvegetated, rubbly colluvium is generally dominant (50-80%) on WH7+CR. Avalanche complex 2 vegetation also occurs in minor amounts on WH1, WH4, and WH6 but occupies 20 to 50% of tracts with the modifier A (*e.g.* WH1A below Vermilion Peak).

WILDLIFE

WH1 Wildlife Features

Ungulates: WH1 is of low importance. The subalpine larch-subalpine fir/grouseberry-everlasting (C23) closed forest combined with deep snow affords little to ungulates. Moderate use by mountain goats year round and elk in summer occurs in the higher elevation subalpine larch-subalpine fir/heather (O13) open forest.

Carnivores: WH1 is of low importance, being highly important only to martens.

Small Mammals: Associations 6 and 5.
Although WH1 supports a large number of species, none occur at high density.

Breeding Birds: Community 7.
A medium density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to White-winged Crossbill and Golden Eagle.

WH4 Wildlife Features

Ungulates: WH4 is moderately important. It is highly important to elk and mountain goats in summer and fall on the south-westerly aspect of Mount Wardle. However a tract sampled in the Verdant Creek valley with similar vegetation but an easterly aspect had very low summer goat use. WH4 may be of high importance to goats elsewhere in KNP where it has a similar aspect, vegetation and association with rocky outcroppings as on Mount Wardle.

Carnivores: WH4 is of low importance.

Small Mammals: Associations 1 and 5.
WH4 is important because of the high diversity of small mammals it supports. However, only pikas occur at high density.

Table 134. Wildlife features of WH Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
WH1	low	goat	low	marten	medium	heather vole	medium
WH4	medium	goat elk	low		high	pika marmot	low
WH6	medium	elk moose	low	marten	high	hare porcupine pika	low
WH7	medium	goat	low		high	pika marmot Columbian gr. squirrel	low
WH8	low	goat	low		medium	marmot Columbian gr. squirrel	low

Breeding Birds: Community 7.
A low density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Golden-crowned Kinglet and Yellow-rumped Warbler.

WH6 Wildlife Features

Ungulates: WH6 is moderately important. All ungulates, except white-tailed deer, were recorded here. Use is low to moderate and restricted to summer and fall. Snow depths >1.8 m were recorded in February, making WH6 unsuitable for wintering ungulates. Low summer use by bighorn sheep was recorded only in the upper Lachine Creek area. Most ungulate use of WH6 is in the subdominant C15 v.t.

Carnivores: WH6 is of low importance, except to martens.

Small Mammals: Association 3.
WH6 supports a moderate number of species at high densities. Pikas, snowshoe hares, porcupines and red-backed voles occur at high densities.

Breeding Birds: Community 8.
A low density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Northern Goshawk and Golden-crowned Kinglet.

WH7 Wildlife Features

Ungulates: WH7 is moderately important to mountain goats and elk in summer and moose in winter in S2 and S8 v.t.s. Two plots in O4 and H17 v.t.s on a south facing WH7 above Ochre Creek were very highly important to mountain goats in summer.

Carnivores: The importance of WH7 is low.

Small Mammals: Associations 8, 3 and 6.
WH7 has a high species diversity with pikas, hoary marmots and Columbian ground squirrels occurring at high densities.

Breeding Birds: Communities 7, 8 and 12.
A low density of birds was recorded. Species diversity is medium. Based on density indices derived from circular census plots, this Ecosite is highly important to Rosy Finch.

WH8 Wildlife Features

Ungulates: WH8 is of low importance. Moderate summer use was recorded for elk and mountain goats.

Carnivores: WH8 is of low importance.

Small Mammals: Associations 8, 1 and 5.
WH8 supports a moderate number of species at moderate densities. Hoary marmots and porcupines occur at high densities.

Breeding Birds: Communities 7, 17 and 18.
A low density of birds was recorded. Species diversity is low. Based on density indices derived from circular census plots, this Ecosite is highly important to Rosy Finch and Water Pipit.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The WH Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and modified slightly to accommodate similar landscape (8.5%) in KNP. Likewise, WH1 (0.9%) was extended, with minor modification, to KNP. WH4 (2.1%), WH6 (2.8%), WH7 (2.5%), and WH8 (0.3%) were added to distinguish KNP landscape with subdominant Eutric Brunisols from BNP and JNP landscape where soils with pH ≥ 5.5 are uncommon. This distinction is linked to the unpredictable but common occurrence of low-lime colluvium in WH tracts in KNP and to the variability in weathering reflecting duration and degree of site stability.

WH is the Upper Subalpine counterpart of the Lower Subalpine Fairview (FV) and the Alpine Redoubt (RD) Ecosections. The Wildflower (WF) and Endless Chain (EN) Ecosections resemble WH. However, WF occurs on calcareous colluvial materials (Colluvial materials C and D) derived from carbonate and calcareous clastic bedrock and is characterized by more alkaline, often calcareous soils, including Regosols and Eutric Brunisols. EN occurs on Colluvium A (noncalcareous, coarse textured) derived from quartzitic bedrock.

Steepness and colluviation are major limitations. The Ecosites from most to least active are: WH7 (avalanched), WH4 (craggy), WH8 (solifluCted), and the others (forested). Removal of vegetation may increase erosion, and revegetation may be slow on WH8.

WY - WYCLIFFE ECOSECTION

The Wycliffe (WY) Ecosection concept incorporates: Montane Douglas fir and grassland vegetation; glacial landforms of calcareous, medium to fine textured tills (Tills C and D) and calcareous, variably textured, ice contact stratified drift (Ice Contact Stratified Drift B); and well to rapidly drained, thin, weakly developed Eutric Brunisols. The semiarid soils and vegetation of WY reflect the warmest, driest mesoclimate within KNP (Climate, Chap. I). WY is generally restricted to elevations <1250 m on benchlands and lower walls of the Columbia River valley in southwestern KNP. Two WY Ecosites (Table 135) were differentiated. WY1 is more homogeneous than WY2, the latter having distinct but cartographically inseparable aspect and exposure differences (***northerly vs. southerly***) that correspond to major soil and vegetational differences. Fig. 24 illustrates topographic relationships among WY1, WY2 and other Ecosites.

GEOMORPHOLOGY

WY is characterized by glacial landforms of Tills C and D (calcareous, medium and fine textured, respectively) and Ice Contact Stratified Drift B (calcareous, variably textured). These materials were derived from limestone, shale, and slate along the floor and east wall of the Rocky Mountain Trench.

Fig. 24. Landscape schematic of topographic relationships among WY and other Ecosites.

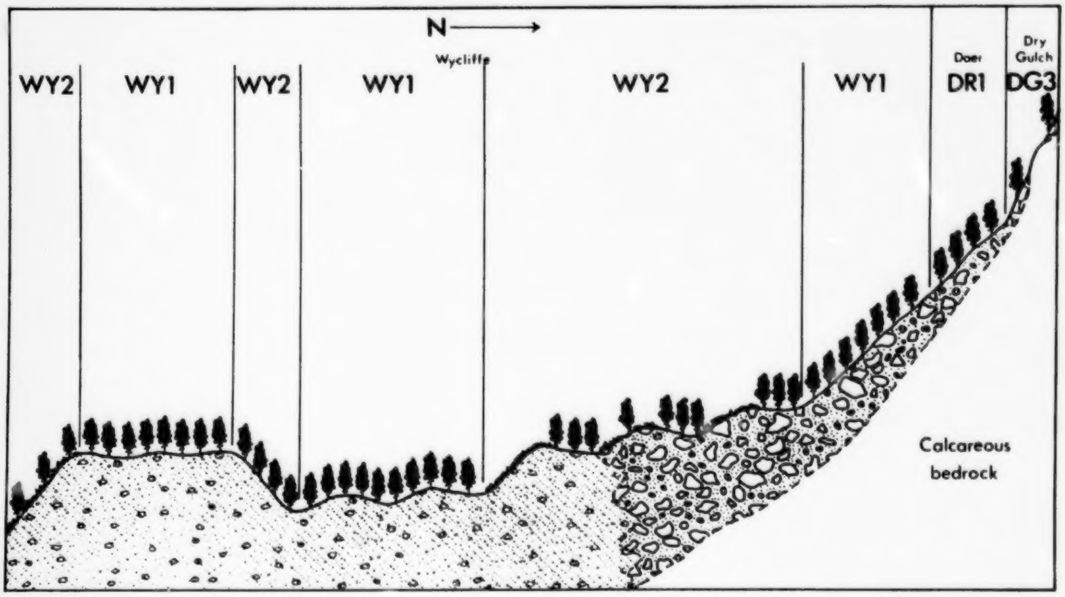


Table 135. Definitive features of Wycliffe (WY) Ecosites.

Eco-site	Landform	Soils	Vegetation
WY1	Tills C & D, Ice Contact Stratified Drift B; blanket over inclined bedrock, hummocky	Orthic Eutric Brunisol	Douglas fir forest (C1)
WY2	Ice Contact Stratified Drift B, Tills C & D; inclined, hummocky & ridged, blanket over inclined bedrock; gullied	Northerly: Orthic Eutric Brunisol	Douglas fir forest (C1)
		Southerly: Orthic Regosol, Orthic Humic Regosol, Rego Dark Brown	Douglas fir open forest (O5), dry grassland (H6, H19)

Ice contact material dominates the benchland and is strongly stratified (Plate 1) with no extensive areas of glaciofluvial or glaciolacustrine sediments. The till mixture dominates the lower valley wall. WY2 is most extensive on the benchland, WY1 on the lower valley wall. Thin, discontinuous veneers of Eolian material A (calcareous, medium textured) and B (altered, medium textured) mantle the glacial materials. These are most extensive on gently sloping benchlands. Colluvial materials, derived locally from glacial materials and bedrock, occasionally occur as veneers on the steepest WY2 slopes. Some tracts on the benchland include small fluvial fans at the mouths of large gullies cut in the valley wall.

The till mixture commonly occurs as a blanket with long, straight, inclined slopes (30-70%) that reflect the underlying bedrock on the lower valley walls. The deep ice contact stratified drift forms moraine-like landforms on the benchland. Hummocky and ridged surfaces, with complex slopes of 2 to 30%, are typical. Some WY2 tracts have short, steep (45-70%), straight slopes produced by streams cutting through glacial deposits of the valley benchland and wall. Such erosional scarps were mapped singly or as two opposing slopes separated by a narrow fluvial plain.

Deep, closely spaced gullies oriented perpendicular to the contour usually dissect the steep erosional slopes. Such extremely gullied land has many aspect and exposure differences that contribute to strongly contrasting soil and vegetational features. Gullies and channels contribute to the topographic complexity of some hummocky and ridged WY2 tracts. Generally however, the bedrock controlled and depositional landforms are less gullied than the erosional scarps.

SOILS

Soils characteristic of the WY Ecosection are well to rapidly drained Orthic Eutric Brunisols with thin sola, high base saturation and pH, and weakly developed Bm horizons without luvisolic tendencies. Luvisolic soils are rare in WY. Eluvial (Ae) horizons are usually absent and thin organo-mineral (Ah) horizons often occur at the surface instead. An Orthic Eutric Brunisol pedon (Table D34, Plate 64), from the WY1 tract east of Radium, illustrates the features indicative of a semiarid climate. Orthic Eutric Brunisols typify WY1 and northerly aspects of WY2, and are associated with Douglas fir closed forest. Orthic Regosols also occur occasionally under closed forest but only where erosion and deposition have recently occurred.

Rapidly drained soils under grassland and Douglas fir open forest on southerly aspects of WY2 are more complex than the Eutric Brunisols described above and the classification is tenuous. Orthic Regosols occur on the steepest slopes where soil creep and other shallow colluvial processes inhibit pedogenic development, including Ah development in the most active sites. Ah horizons of varying thickness and kind are usually present however. Soils with non-Chernozemic Ah horizons are Orthic Regosols or Orthic Humic Regosols, depending on Ah thickness. A pedon (Table D35, Plate 65), from the WY2 tract above the Radium Golf Course, illustrates soils with thick ($\geq$10 cm) Ah. It is likely that Chernozemic Ah horizons (C:N ratio <17, mean annual soil temperature >0°C) also occur (Marshall n.d., McLean and Holland 1958, Kelley and Holland 1961, Wittneben 1980), the soils thus being Chernozemic. Those resembling Orthic Humic Regosols would be Rego Dark Browns. Occasionally, an Ah-Bmk horizon sequence of sufficient thickness for Calcareous Dark Brown occurs on gently sloping, stable sites such as hummock and ridge crests.

VEGETATION

WY1 and the stable, mesic northerly aspects of WY2 are characterized by the Douglas fir/hairy wild rye (C1) v.t. (Plate 66). Associated soils are well to rapidly drained Orthic Eutric Brunisols. C1 on these landscapes has a well developed, grassy, herb-dwarf shrub layer dominated by pine grass (*Calamagrostis rubescens*) and a sparse shrub layer in which juniper (*Juniperus scopulorum*) is common. Accessory v.t.s on northerly aspects of WY2 are white spruce-Douglas fir/feathermoss (C5) on cool, moist sites and lodgepole pine/buffaloberry/pine grass (C38) in depressions.

In sharp contrast are the drier, subxeric southerly aspects of WY2 (Plate 67) that are dominated by the Douglas fir/juniper/bearberry (O5), junegrass-pasture sage-wild blue flax (H6) (Corns and Achuff 982) and bluebunch wheatgrass-hairy wild rye-showy aster (H19) v.t.s. Douglas fir-ponderosa pine/wheatgrass (O24) is an accessory v.t. and occurs along Stoddart Creek. Intergrades among the four v.t.s and with C1 on more protected slopes also occur. Here O5 varies from the modal concept because of a well developed, grassy, herb-dwarf shrub layer that resembles H6 or H19. It also contains Rocky Mountain juniper (*Juniperus scopulorum*) and rabbit brush (*Chrysothamnus nauseosus*) which rarely occur elsewhere in KNP. The grassland v.t.s have a restricted distribution with H6 occurring on gentle slopes and H19 (Plate 68) on steep slopes. Soils associated with the southerly aspects of WY2 are rapidly drained Regosols, Humic Regosols, and Rego Dark Browns. Slopes vary from 2 to 70% and aspects range from east through south to west but are labelled southerly for convenience.

WILDLIFE

WY1 Wildlife Features

Ungulates: WY1 is very highly important to deer (primarily mule deer) in winter due to low snow accumulation and high forage availability. WY1 is also highly important to bighorn sheep, especially in winter. This Douglas fir dominated Ecosite is primarily used by sheep for travel but also contains man-made grasslands (Redstreak campground, Administration Building, Radium Golf Course) which provide winter forage.

Carnivores: The high availability of prey, particularly in winter makes WY1 very highly important to coyotes, cougars and lynx.

Small Mammals: Associations 2 and 3.
A moderate number of species occurs here at high densities. Very high numbers of snowshoe hares occur and high numbers of red squirrels, Columbian ground squirrels, red-backed voles and deer mice also occur.

Breeding Birds: Community 3.
A very high density of birds was recorded. Species diversity is high. Based on density indices derived from circular census plots, this Ecosite is highly important to Western Tanager, Warbling Vireo, Solitary Vireo, Ruffed Grouse, Chipping Sparrow, American Robin, Common Raven, Mountain Chickadee, and Dark-eyed Junco.

WY2 Wildlife Features

Ungulates: WY2 contains the majority of natural grassland in KNP and this, combined with low snow accumulation, makes it very highly important as bighorn sheep winter range. These areas are also of high importance to wintering deer and elk. WY2 in combination with DG3/H19 tracts in the Dry Gulch to Stoddart creeks area is the primary bighorn sheep winter range in KNP.

Carnivores: Similar to WY1, WY2 is very highly important to coyotes and cougars.

Small Mammals: Associations 1 and 2.
WY2 supports a moderate number of species, with Columbian ground squirrels and red squirrels occurring at high densities.

Breeding Birds: Communities 1, 3 and 5.
A high density of birds was recorded. Species diversity is high. Based on density indices derived from circular census plots, this Ecosite is highly important to Western Tanager, Vesper Sparrow, Solitary Vireo, Rock Wren, Chipping Sparrow, Cassin's Finch, Dusky Flycatcher, Dark-eyed Junco, and Red-breasted Nuthatch.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

WY covers 0.5% of KNP and resembles the Norquay (NY) Ecosection of the BNP and JNP ecological inventory (Walker *et al.* 1982d). Textural differences reflecting different bedrock warrant the separation. NY is characterized by coarser textured till (Till C) derived from resistant limestones. The WY Ecosection correlates with the Wycliffe (WY) Soil Association (Wittneben 1980, Lacelle 1982) of British Columbia soil surveys in and around KNP (Appendix C).

WY1 (0.3%) and WY2 (0.2%) resemble Daer 1 and 5 (DR1 and DR5), respectively. DR occurs in Montane areas to the east and north and at higher elevations with a cooler, moister mesoclimate than WY. Eutric Brunisols of DR are better developed than those of WY and Luvisolics are subdominant in DR. Further, southerly aspects of DR5 are dominated by Douglas fir closed forest and have fewer Regosolics than the dry, exposed slopes of WY2.

Table 136. Wildlife features of WY Ecosites.

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
WY1	high	deer sheep	very high	coyote cougar lynx	high	hare Columbian gr. squirrel red squirrel deer mouse red-b. vole	very high
WY2	very high	deer elk sheep	high	coyote cougar	medium	Columbian gr. squirrel red squirrel deer mouse	high

WY2 has two distinctive but cartographically inseparable landscape segments that can be separated at larger scales. The northerly aspect becomes mappable as WY1 and the southerly aspect becomes an undefined Ecosite.

Use is limited by shallow depth to lime, droughtiness, and where slopes are steep or topography is irregular. Locally, use may be affected by surface colluviation, gullies, and gravelly coarse textured ice contact stratified drift. Removal of vegetation may result in erosion on steep slopes. This is the only Ecosection where Chernozemic soils occur.

WY contains critical winter range for bighorn sheep and mule deer. Plants and animals occur here which do not occur elsewhere in the park.

ECOSITE MODIFIERS

A - AVALANCHED

The Ecosite Modifier **Avalanched** (A) is added to a map symbol when 20 to 50% of the tract is modified by snow avalanches and the modification is not part of the Ecosite concept (Plate 69). The modifier is used on many tracts in the Montane and Subalpine Ecoregions. Avalanche processes and terminology are described by Perla and Martinelli (1975). Avalanching affects mainly vegetation and to a lesser extent soils. Common v.t.s on avalanche paths include subalpine fir-willow (S2), green alder/fern (S13), aspen-dwarf birch/bearberry (S16), hairy wild rye-wild strawberry-fireweed (H5), fleabane-valerian (H16), fireweed-meadow rue (H22) and aspen/hairy wild rye-showy aster (C22).

Management Considerations

Ecosites affected by avalanching require modified management considerations, particularly for winter uses.

B - BURNED

The Ecosite Modifier **Burned** (B) is used when $\geq$50% of the vegetation of a tract is modified by recent fire. It is used on many tracts in the Subalpine Ecoregion. In the Vermilion Pass area, lodgepole pine/twinflower-fireweed (S5) is a common Lower Subalpine v.t. that has developed since the 1968 fire (Plate 70). In other burned localities the vegetation either includes variants of recognized v.t.s or may not be a recognized v.t. Much of the Kootenay River valley was burned between 1920 and 1930 but little was mapped with modifier **B** because recognizable v.t.s have developed in the intervening 55 to 60 years.

Management Considerations

Burned areas may be conducive to accelerated rates of erosion, especially in the few years immediately following fire. They are often favorable for wildlife since fire usually results in forest being replaced by herbaceous or shrubby vegetation. Also, burned areas may serve as a research sites to determine the pathways and rates of vegetational succession.

F - FAILED

The Ecosite Modifier **Failed** (F) is used to identify three types of landscape. The first encompasses extinct rock glaciers that originated as talus and protalus ramparts below rock walls. The second type includes failure of bedrock plus overburden that has created irregular, hummocky to ridged, bench-like topography often superimposed on an inclined slope. Tension cracks and, on limestone bedrock, localized karst features may be present. The third type encompasses severe solifluction that has produced prominent solifluction lobes. Use of the modifier Failed in this inventory is broader than the definition of the Canada Soil Survey Committee (C.S.S.C. 1978b). Failed landscapes occur in both the Subalpine and Alpine Ecoregions.

Management Considerations

Failed tracts with old rock glacier landforms should not receive changed management consideration because the rock glaciers are not expected to reactivate. Failed terrain that includes mass movement and severe solifluction will influence management considerations for park uses. Such tracts should be evaluated individually to determine the potential for further slope failure.

X - LITHIC

The Ecosite Modifier **Lithic** (X) is added to a map symbol when $\geq$50% of a tract has shallow, unconsolidated material overlying a lithic layer and lithic phase soils are not part of the Ecosite concept. A lithic layer is a consolidated bedrock layer within the control section below a depth of 10 cm (C.S.S.C. 1978a). The control section of most mineral soils in KNP is 1 m. Even though lithic phase soils dominate X-modified tracts, bedrock outcrops may not be abundant. Lithic-modified tracts occur in all Ecoregions.

Management Considerations

Shallow soils and bedrock will change management considerations for Lithic Ecosites. Uses that require deep unconsolidated material (*e.g.* sewage disposal) will be precluded.

MISCELLANEOUS LANDSCAPES

CL - COLLUVIAL LANDSLIDE

The Miscellaneous Landscape **Colluvial Landslide** (CL) consists of post- and supraglacial landslide materials. Only one tract of CL occurs in KNP, accounting for <0.1% of the park. It occurs in the Upper Subalpine in Tokuum Creek valley. The landslide is likely due to failure that detached large blocks of Cathedral Formation limestone from the mountain slope above. Hummocky topography plus blocky and rubbly material dominated by nonsoil reflect massive bedrock and its disintegration due to cataclysmic failure.

CL is >80% unvegetated which distinguishes it from the IB and BP Ecosections, both of which characteristically are >50% vegetated.

Management Considerations

Irregular topography, lack of soil and rubbly, blocky surfaces are the major factors to consider as limitations for most park uses.

CR - COLLUVIAL RUBBLE

The Miscellaneous Landscape **Colluvial Rubble** (CR) consists of Colluvium A, B or C. Physical weathering (joint block separation) of highly jointed bedrock, followed by slow, gravity-induced movement, produces colluvial rubble. This process is less prominent in resistant, massive quartzites, limestones and dolostones. Slow, downslope displacement is caused by surface creep, solifluction and sheet erosion (Plate 71).

Colluvial Rubble occurs in the Subalpine and Alpine Ecoregions and accounts for 1.1% of KNP. The majority of tracts occur in the Upper Subalpine and Alpine with a few bordering the Lower Subalpine. Nonsoil and Regosolic soils dominate CR. Regosolics occur in association with fine earths formed *in situ* by weathering or transported by surface creep, wind, or water erosion. CR tracts may be unvegetated or sparsely vegetated. V.t.s such as saxicolous lichen (H12) and mountain avens-snow willow-moss campion (H1) occur only in patches and occupy <20% of a tract.

Management Considerations

Land stability, as well as lack of soil and vegetation, are major factors limiting most recreational park uses. The colluviation process is slower than for CL and thus, may permit some uses, (*e.g.* trails) but at significant development and maintenance costs.

GL - GLACIER

The Miscellaneous Landscape **Glacier** (GL) includes glacier, firn, icefield and glacierette. GL tracts occur in the Upper Subalpine and Alpine, and account for 1.3% of KNP. Most GL tracts occur in northern KNP near the Continental Divide. GL is absent in the Western Ranges (Fig. 2).

GL is unvegetated and nonsoil. In some cases, colluvial debris mantles glaciers. Compound map units involving GL are M+GL (0.1% of KNP), R+GL (1.5%), and T+GL (0.3%). Tracts labelled with these compound symbols contain inseparable areas of GL plus Recent Morainal (M), Rockland (R), or Talus (T).

Management Considerations

GL areas have scientific, ecological, and tourist interest. The implications for use are complex and require site specific studies by qualified personnel. The ecological concerns involve long term climatic and hydrologic influences of the environment.

M - RECENT MORAINE

The Miscellaneous Landscape **Recent Moraine** (M) is comprised primarily of Till C (calcareous, medium textured) forming hummocky, ridged and inclined, Neoglacial landforms in the Subalpine and Alpine Ecoregions. M tracts commonly occur close to glaciers (Plate 72). Ice retreat from these areas is so recent that Regosolics and nonsoil are characteristic. Unvegetated portions dominate (usually >80%) and show virtually no soil development. Where vegetation occurs, yellow dryad-willow herb (H8) is the usual v.t. Regosolic soils with little horizon development are common under vegetated patches.

All tracts designated by the symbol M, whether singly or as part of a compound symbol, account for 1.6% of KNP. Tracts of M alone account for 0.5%. Compound map units involving M are M+GL (0.1% of KNP), M+R (0.4%), and T+M (0.6%). Tracts labelled with the compound symbols contain inseparable areas of M plus Glacier (GL), Rockland (R), or Talus (T). Only one tract is labelled with an Ecosite+M compound symbol. It is PL4F+M occuring between Split Peak and Spar Mountain.

Management Considerations

Areas of Recent Moraine have scientific, ecological, and tourist interest, paricularly for geomorphological and pedological studies, as well as paleoecological studies of vegetational succession. The lack of soil and vegetation preclude many recreational park uses.

P - PITS

The Miscellaneous Landscape **Pits** (P) identifies localities where unconsolidated and consolidated materials are displaced by human activities. These include borrow pits, fill sites, gravel pits and quarries along transportation corridors and quarries. Because of small size and the 1:50,000 map scale, many small pits cannot be mapped. Mappable tracts account for <0.1% of KNP.

Management Considerations

Some Pits have been used as overflow campgrounds. These highly disturbed areas could often benefit from reclamation to blend them into the landscape more aesthetically and restore their biological productivity.

R - ROCKLAND

The Miscellaneous Landscape **Rockland** (R) is composed of consolidated bedrock of all lithologies and occurs in all Ecoregions of KNP. Rockland is more abundant on resistant than recessive rock and is dominantly nonsoil and unvegetated. Some tracts are sparsely vegetated with v.t.s such as saxicolous lichen (H12) and mountain avens-snow willow-moss campion (H1). Some R tracts have stunted trees growing in cracks and small, shallow pockets of soil.

All tracts designated by the symbol R, whether singly or as part of a compound symbol, account for 11.2% of KNP. Tracts of R alone account for 1.0%. Compound map units involving R are M+R (0.4% of KNP), R+CR (4.4%), R+GL (1.5%), and R+T (3.8%). Tracts labelled with the compound symbols contain inseparable areas of R plus Recent Morainal (M), Colluvial Rubble (CR), Glacier (GL), and Talus (T). Infrequently, R is complexed with an Ecosite symbol (*e.g.* DR5+R, RD2+R) to tracts in which bedrock outcrops are abundant and not part of the Ecosite concept.

Management Considerations

Lack of soil and vegetation preclude many recreational park uses. Steepness and safety problems are other limitations to their use. Aesthetic values are high, as is their use for geological studies.

RG - ROCK GLACIER

The Miscellaneous Landscape **Rock Glacier** (RG) is a mass of poorly sorted, angular coarse fragments and fine earth material cemented by interstitial ice $\geq$1 m below the surface. RG is a product of colluvial and glacial processes. Material is fed from talus (protalus ramparts) along cirque and valley walls. The surface of RG is marked by a series of transverse, arcuate, and rounded ridges suggestive of slow flow (Plate 73). These forms probably result from a combination of flow and melting of interstitial or underlying ice. RG is dominantly nonsoil and unvegetated. Regosolics occur on older portions where vegetation has become established. RG occurs mostly in the Upper Subalpine and Alpine and accounts for 0.2% of KNP. Where inseparable from Talus (T), the landscape is mapped as T+RG (0.6% of KNP).

Management Considerations

RG areas are of scientific, ecological, and tourist interest. Steepness and lack of soil and vegetation are severely limiting factors for most recreational park uses.

T - TALUS

The Miscellaneous Landscape **Talus** (T) consists of loose deposits of Colluvium A, B or C that include abundant, angular, coarse fragments. Talus is formed chiefly by gravitational falling, rolling or sliding of fragments dislodged by physical weathering from very steep, resistant rock walls. In some cases, mudflows and avalanches also deposit material (Gray 1972, Luckman 1972, Ryder 1981). Talus occurs as steep, usually concave slopes in the form of cones, aprons and fans. Material thickness diminishes from the bottom to the top of a slope with smaller fragments more abundant near the top. The upper slope is usually steeper than the lower slope. Talus has dominantly nonsoil or Regosolics and is unvegetated. A few tracts have sparse vegetation. T tracts occur in the Subalpine and Alpine Ecoregions.

All tracts designated by the symbol, whether singly or as part of a compound symbol, account for 6.2% of KNP. Tracts of T alone account for 0.9%. Compound map units involving T are R+T (3.8% of KNP), T+GL (0.3%), T+M (0.6%), and T+RG (0.6%). Tracts labelled with the compound symbols contain inseparable areas of T plus Rockland (R), Glacier (GL), Recent Moraine (M), and Rock Glacier (RG). Ecosites characterized by colluvial landforms also may be complexed with T (*e.g.* SB1+T).

Management Considerations

Steepness, instability, and lack of soil and vegetation result in severe limitations for most recreational park uses.

WATER BODIES

The Miscellaneous Landscape **Water Bodies** (colored blue on the map) includes lakes, ponds, and streams occurring in all Ecoregions. Water Bodies are delineated at the high water level where seasonal fluctuations are evident. Mappable Water Bodies account for about 0.4% of KNP.

Management Considerations

Water bodies are described by Donald and Alger (1984, Alger and Donald 1984).

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APPENDIX A - PLANTS OF KOOTENAY NATIONAL PARK

This list is based on collections made during the ecological land classification and those in the KNP herbarium. Nomenclature for vascular plants follows primarily Packer (1983) and Hitchcock and Cronquist (1973), for liverworts Stotler and Crandall-Stotler (1977), for mosses Crum *et al.* (1973), and for lichens Hale and Culberson (1970) and Hawksworth *et al.* (1980). KNP has a total of 677 vascular taxa, 27 liverwort taxa, 133 moss taxa and 156 lichen taxa.

LYCOPODIOPHYTA

LYCOPODIACEAE

Lycopodium alpinum L.
Lycopodium annotinum L.
Lycopodium clavatum L.
Lycopodium complanatum L.
Lycopodium selago L.
Lycopodium sitchense Rupr.

SELAGINELLACEAE

Selaginella densa Rydb.
Selaginella selaginoides (L.) Link

EQUISETOPHYTA

EQUISETACEAE

Equisetum arvense L.
Equisetum fluviatile L.
Equisetum hyemale L.
Equisetum pratense Ehrh.
Equisetum scirpoides Michx.
Equisetum sylvaticum L.
Equisetum variegatum Schleich.

POLYPODIOPHYTA

OPHIOGLOSSACEAE

Botrychium lunaria (L.) Sw.
Botrychium matricariaefolium (Doell) A. Br.
Botrychium virginianum (L.) Sw.

POLYPODIACEAE

Asplenium viride Huds.
Athyrium filix-femina (L.) Roth
Cheilanthes feei Moore

Cystopteris fragilis (L.) Bernh.
Cystopteris montana (Lam.) Desv.
Dryopteris assimilis S. Walker
Gymnocarpium dryopteris (L.) Newm.
Pellaea glabella Mett. *ex* Kuhn
Polystichum lonchitis (L.) Roth
Woodsia oregana Eat.
Woodsia scopulina Eat.

PINOPHYTA

CUPRESSACEAE

Juniperus communis L.
Juniperus horizontalis Moench
Juniperus scopulorum Sarg.
Thuja plicata Don

PINACEAE

Abies lasiocarpa (Hook.) Nutt.
Larix lyallii (DuRoi) Koch
Larix occidentalis Nutt.
Picea engelmannii Parry
Picea glauca (Moench) Voss
Pinus albicaulis Engelm.
Pinus contorta Loud. var. *latifolia* Engelm.
Pinus flexilis James
Pinus ponderosa Dougl. *ex* Lawson
Pseudotsuga menziesii (Mirb.) Franco var. *glauca* (Beissn.) Franco
Tsuga heterophylla (Raf.) Sarg.

MAGNOLIOPHYTA

MAGNOLIATAE

ACERACEAE

Acer glabrum Torr. var. *douglasii* (Hook.) Dippel

APOCYNACEAE

Apocynum androsaemifolium L.

ARALIACEAE

Aralia nudicaulis L.
Oplopanax horridum (Sm.) Miq.

BERBERIDACEAE

Berberis repens Lindl.

BETULACEAE

Alnus crispa (Ait.) Pursh = *A. viridis* (Chaix) DC. ssp. *crispa* (Ait.) Turr.
Betula glandulosa Michx.
Betula occidentalis Hook.
Betula papyrifera Marshall
Betula pumila L. var. *glandulifera* Regel
Betula x sargentii Dugle

BORAGINACEAE

Cynoglossum officinale L.
Hackelia floribunda (Lehm.) Johnston
Hackelia jessicae (McGreg.) Brand
Lappula echinata Gilib. = *L. squarrosa* (Retz.) Dumort.
Lithospermum incisum Lehm.
Lithospermum ruderale Douglas *ex* Lehm.
Mertensia longiflora Greene
Myosotis alpestris Schm.

CAMPANULACEAE

Campanula rotundifolia L.

CAPRIFOLIACEAE

Linnaea borealis L.
Lonicera dioica L.
Lonicera involucrata (Rich.) Banks
Lonicera utahensis Wats.
Sambucus coerulea Raf.
Sambucus racemosa L. var. *melanocarpa* (Gray) McMinn
Symphoricarpos albus (L.) Blake
Symphoricarpos occidentalis Hook.
Viburnum edule (Michx.) Raf.

CARYOPHYLLACEAE

Arenaria capillaris Poir.
Arenaria lateriflora L. = *Moehringia lateriflora* (L.) Fenzl.
Cerastium arvense L.
Cerastium beeringianum Cham. & Schl.
Cerastium vulgatum L.
Minuartia biflora (L.) Schinz. & Thell. = *Arenaria sajanensis* Willd.
Minuartia dawsonensis (Britt.) House
Minuartia elegans (C. & S.) Schischk. = *Arenaria rossii* R.Br.
Minuartia nuttallii (Pax) Briq. = *Arenaria nuttallii* Pax
Minuartia obtusiloba (Rydb.) House = *Arenaria obtusiloba* (Rydb.) Fern.

Minuartia rubella (Wahl.) Graebn. = *Arenaria rubella* (Wahl.) Smith
Silene acaulis L.
Silene drummondii Hook. = *Lychnis drummondii* (Hook.) Wats.
Silene menziesii Hook.
Silene parryi (Wats.) Hitchc. & Mag.
Silene scouleri Hook.
Silene uralensis (Rupr.) Bocq. = *Lychnis apetala* L.
Stellaria calycantha (Ledeb.) Bong.
Stellaria longipes Goldie

CELASTRACEAE

Pachystima myrsinites (Pursh) Raf.

CHENOPODIACEAE

Chenopodium album L.
Chenopodium capitatum (L.) Aschers.
Chenopodium fremontii Wats.

COMPOSITAE

Achillea millefolium L.
Agoseris aurantiaca (Hook.) Greene
Agoseris glauca (Pursh) Raf.
Anaphalis margaritacea (L.) Benth. & Hook.
Antennaria alpina (L.) Gaertn.
Antennaria anaphaloides Rydb.
Antennaria corymbosa Nels.
Antennaria lanata (Hook.) Greene
Antennaria neglecta Greene
Antennaria nitida Greene = *A. microphylla* Rydb.
Antennaria parvifolia Nutt.
Antennaria pulcherrima (Hook.) Greene
Antennaria racemosa Hook.
Antennaria rosea Greene
Antennaria umbrinella Rydb.
Anthemis tinctoria L.
Arnica alpina (L.) Olin = *A. angustifolia* Vahl
Arnica cordifolia Hook.
Arnica latifolia Bong.
Arnica louiseana Farr
Arnica mollis Hook.
Arnica parryi Gray
Arnica rydbergii Greene
Arnica sororia Greene
Artemisia campestris L.
Artemisia cana Pursh
Artemisia dracunculus L.
Artemisia frigida Willd.
Artemisia michauxiana Bess.
Aster alpinus L. var. *vierhapperi* Onno
Aster borealis (Torr. & Gray) Prov.
Aster campestris Nutt.
Aster ciliolatus Lindl.
Aster conspicuus Lindl.
Aster ericoides L.

Aster engelmannii (D.C. Eat.) Gray
Aster foliaceus Lindl. = *A. subspicatus* Nees
Aster laevis L.
Aster laevis Lindl.
Aster sibiricus L.
Balsamorhiza sagittata (Pursh) Nutt.
Chrysanthemum leucanthemum L.
Chrysopsis villosa (Pursh) Nutt. = *Heterotheca villosa* (Pursh) Shinners
Chrysothamnus nauseosus (Pall.) Britt.
Cirsium arvense (L.) Scop.
Cirsium hookerianum Nutt.
Cirsium undulatum (Nutt.) Spreng.
Crepis atrabarba Heller
Crepis elegans Hook.
Crepis nana Richards.
Erigeron acris L.
Erigeron aureus Greene
Erigeron compositus Pursh
Erigeron corymbosus Nutt.
Erigeron elatus Hook.
Erigeron filifolius (Hook.) Nutt.
Erigeron glabellus Nutt.
Erigeron humilus Graham
Erigeron lanatus Hook.
Erigeron lonchophyllus Hook.
Erigeron pallens Cronq. = *E. purpuratus* Greene ssp. *pallens* (Cronq.) G. Douglas
Erigeron peregrinus (Pursh) Greene
Erigeron pumilus Nutt.
Gaillardia aristata Pursh
Haplopappus lyallii Gray
Helenium autumnale L. var. *grandiflorum* (Nutt.) Torr. & Gray
Hieracium albertinum Farr = *H. cynoglossoides* Arv.-Touv.
Hieracium albiflorum Hook.
Hieracium canadense Michx.
Hieracium triste Willd. ssp. *gracile* (Hook.) Calder and Taylor = *H. gracile* Hook.
Hieracium umbellatum L.
Lactuca pulchella (Pursh) DC. = *L.p.* ssp. *tatarica* (Pursh) Stebbins
Lactuca serriola L.
Lygodesmia juncea (Pursh) Don
Matricaria matricarioides (Less.) Porter
Petasites palmatus (Ait.) Gray
Petasites sagittatus (Banks) Gray
Petasites vitifolius Greene
Rudbeckia hirta L.
Saussurea densa (Hook.) Rydb. = *S. nuda* Ledeb. var. *densa* (Hook.) Hult.
Senecio canus Hook.
Senecio congestus (R. Br.) DC.
Senecio fremontii Torr. & Gray
Senecio integerrimus Nutt. var. *exaltatus* (Nutt.) Cronq.
Senecio lugens Richards.
Senecio pauperculus Michx.
Senecio pseudaureus Rydb.
Senecio streptanthifolius Greene
Senecio triangularis Hook.
Solidago canadensis L.
Solidago missouriensis Nutt.
Solidago multiradiata Ait.
Solidago nemoralis Ait.
Solidago rigida L. var. *humilis* Porter
Solidago spathulata DC. var. *nana* (Gray) Cronq. = *S. decumbens* Greene
Solidago spathulata DC. var. *neomexicana* (Gray) Cronq.
Sonchus arvensis L.
Sonchus uliginosus Bieb.

Stephanomeria tenuifolia (Torr.) Hall = *S. runcinata* Nutt.
Taraxacum ceratophorum (Ledeb.) DC.
Taraxacum laevigatum (Willd.) DC.
Taraxacum lyratum (Ledeb.) DC.
Taraxacum officinale Weber
Townsendia hookeri Beaman
Tragopogon dubius Scop.

CORNACEAE

Cornus canadensis L.
Cornus stolonifera Michx.

CRASSULACEAE

Sedum lanceolatum Torr.
Sedum roseum (L.) Scop.

CRUCIFERAE

Arabis divaricarpa Nels.
Arabis drummondii Gray
Arabis glabra (L.) Bernh.
Arabis hirsuta (L.) Scop.
Arabis holboellii Hornem.
Arabis lemmonii Wats.
Arabis lyallii Wats.
Arabis lyrata L.
Arabis nuttallii Robins.
Brassica campestris L.
Braya humilis (C.A. Meyer) Robins.
Capsella bursa-pastoris (L.) Medic.
Cardamine breweri Wats.
Cardamine oligosperma Nutt.
Descurainia pinnata (Walt.) Britt.
Descurainia richardsonii (Sweet) O.E. Schulz
Descurainia sophia (L.) Webb
Draba albertina Greene
Draba aurea Vahl
Draba borealis DC.
Draba cana Rydb.
Draba crassifolia Grah.
Draba incerta Payson
Draba lonchocarpa Rydb. var. *lonchocarpa*
Draba oligosperma Hook.
Draba paysonii Macbr.
Draba porsildii Mulligan
Draba praealta Greene
Draba stenoloba Ledeb.
Erucastrum gallicum (Willd.) Schulz
Erysimum asperum (Nutt.) DC.
Erysimum cheiranthoides L.
Erysimum inconspicuum (Wats.) MacM.
Lepidium densiflorum Schrad.
Lepidium ramosissimum Nels.
Lesquerella douglasii Wats.
Physaria didymocarpa (Hook.) Gray

Rorippa islandica (Oeder) Borbas. = *R. palustris* (L.) Besser
Sisymbrium altissimum L.

DROSERACEAE

Drosera anglica Huds.

ELAEAGNACEAE

Elaeagnus commutata Bernh. *ex* Rydb.
Shepherdia canadensis (L.) Nutt.

EMPETRACEAE

Empetrum nigrum L.

ERICACEAE

Arctostaphylos rubra Rehd. & Wils.
Arctostaphylos uva-ursi (L.) Spreng.
Cassiope mertensiana (Bong.) Don
Cassiope tetragona (L.) Don var. *saximontana* (Small) Hitchc.
Gaultheria hispidula (L.) Muhl.
Gaultheria humifusa (Graham) Rydb.
Gaultheria ovatifolia Gray
Kalmia polifolia Wang. var. *microphylla* (Hook.) Heller
Ledum glandulosum Nutt.
Ledum groenlandicum Oeder
Menziesia glabella Gray = *M. ferruginea* Smith var. *glabella* (Gray) Peck
Oxycoccus microcarpus Turcz.
Phyllodoce empetriformis (Sm.) Don
Phyllodoce glanduliflora (Hook.) Coville
Phyllodoce x intermedia (Hook.) Camp
Rhododendron albiflorum Hook.
Vaccinium caespitosum Michx.
Vaccinium membranaceum Dougl. *ex* Hook.
Vaccinium myrtilloides Michx.
Vaccinium myrtillus L.
Vaccinium ovalifolium Sm.
Vaccinium scoparium Leiberg
Vaccinium vitis-idaea L.

FUMARIACEAE

Corydalis aurea Willd.

GENTIANACEAE

Gentianella amarella (L.) Borner
Gentianella propinqua (Richards.) Gillett
Halenia deflexa (Sm.) Griseb.

GERANIACEAE

Geranium bicknellii Britt.
Geranium richardsonii Fisch. & Trautv.
Geranium viscosissimum Fisch. & Mey.

HALORAGACEAE

Myriophyllum exalbescens Fern.

HYDROPHYLLACEAE

Phacelia hastata Dougl. *ex* Lehm. = *P. heterophylla* Pursh
Phacelia sericea (Graham) Gray
Romanzoffia sitchensis Bong.

LABIATAE

Mentha arvensis L.
Prunella vulgaris L.

LEGUMINOSAE

Astragalus aboriginum Richards.
Astragalus alpinus L.
Astragalus americanus (Hook.) Jones
Astragalus bourgovii Gray
Astragalus dasyglottis Fisch. *ex* DC. = *A. agrestis* Dougl. *ex* Hook.
Astragalus eucosmus Robins.
Astragalus lotiflorus Hook.
Astragalus miser Dougl. var. *serotinus* (Gray) Barneby = *A. decumbens* (Nutt.) Gray
Astragalus robbinsii (Oakes) Gray var. *occidentalis* Wats.
Hedysarum boreale Nutt.
Hedysarum sulphurescens Rydb.
Lathyrus ochroleucus Hook.
Lupinus polyphyllus Lindley
Medicago lupulina L.
Medicago sativa L.
Melilotus alba Desr.
Melilotus officinalis (L.) Lam.
Oxytropis campestris (L.) DC.
Oxytropis deflexa (Pall.) DC.
Oxytropis leucantha (Pall.) Pers.
Oxytropis podocarpa Gray
Oxytropis sericea Nutt.
Thermopsis rhombifolia (Nutt.) Richards.
Trifolium aureum Poll. = *T. agrarium* L.
Trifolium hybridum L.
Trifolium pratense L.
Vicia americana Muhl.
Vicia cracca L.

LENTIBULARIACEAE

Pinguicula vulgaris L.
Utricularia minor L.

LINACEAE

Linum lewisii Pursh

LOBELIACEAE

Lobelia kalmii L.

MENYANTHACEAE

Menyanthes trifoliata L.

ONAGRACEAE

Circaea alpina L.
Epilobium alpinum L. var. *alpinum* = *E. anagallidifolium* Lam.
Epilobium alpinum L. var. *clavatum* (Trel.) Hitchc. = *E. clavatum* Trel.
Epilobium alpinum L. var. *lactiflorum* (Haussk.) Hitchc. = *E. lactiflorum* Haussk.
Epilobium alpinum L. var. *nutans* (Hornem.) Hitchc. = *E. hornemannii* Reichenb.
Epilobium angustifolium L.
Epilobium glaberrimum Barbey
Epilobium glandulosum Lehm. = *E. ciliatum* Raf.
Epilobium latifolium L.
Epilobium palustre L.
Epilobium paniculatum Nutt.
Epilobium watsonii (Trel.) Hitchc. var. *occidentale* Barbey

OROBANCHACEAE

Orobanche fasciculata Nutt.

PLANTAGINACEAE

Plantago major L.

POLEMONIACEAE

Polemonium pulcherrimum Hook.

POLYGONACEAE

Eriogonum umbellatum Torr. = *E. subalpinum* Greene
Oxyria digyna (L.) Hill
Polygonum amphibium L. var. *stipulaceum* (Coleman) Fern.
Polygonum viviparum L.

PORTULACACEAE

Claytonia lanceolata Pursh

PRIMULACEAE

Androsace septentrionalis L.
Dodecatheon conjugens Greene
Dodecatheon pulchellum (Raf.) Merr. = *D. radicatum* Greene
Primula mistassinica Michx.

PYROLACEAE

Chimaphila umbellata (L.) Bart.
Moneses uniflora (L.) Gray
Pyrola asarifolia Michx.
Pyrola chlorantha Sw. = *P. virens* Schweig.
Pyrola elliptica L.
Pyrola minor L.
Pyrola secunda L. = *Orthilia secunda* (L.) House

RANUNCULACEAE

Actaea rubra (Ait.) Willd.
Anemone drummondii Wats.
Anemone multifida Poir.
Anemone occidentalis Wats.
Anemone parviflora Michx.
Anemone patens L.
Aquilegia brevistyla Hook.
Aquilegia flavescens Wats.
Caltha leptosepala DC.
Clematis tangutica (Max.) Korsh.
Clematis verticellaris DC. var. *columbiana* (Nutt.) Gray
Delphinium bicolor Nutt.
Delphinium glaucum Wats.
Delphinium nuttallianum Pritz. *ex* Walp.
Ranunculus abortivus L.
Ranunculus acris L.
Ranunculus cymbalaria Pursh
Ranunculus eschscholtzii Schlecht.
Ranunculus inamoenus Greene
Ranunculus occidentalis Nutt.
Ranunculus pedatifidus J.E. Smith
Ranunculus pygmaeus Wahl.
Ranunculus reptans L. = *R. flammula* L.
Ranunculus verecundus B.L. Robins.

Thalictrum occidentale Gray
Thalictrum venulosum Trel.
Trollius albiflorus (Gray) Rydb.

RHAMNACEAE

Ceanothus sanguineus Pursh
Ceanothus velutinus Dougl. *ex* Hook.

ROSACEAE

Amelanchier alnifolia Nutt.
Dryas drummondii Richards.
Dryas octopetala L. var. *hookeriana* (Juz.) Breit.
Fragaria virginiana Duchesne var. *glauca* Wats.
Geum allepicum Jacq.
Geum macrophyllum Willd. var. *perincisum* (Rydb.) Raup
Geum triflorum Pursh
Luetkea pectinata (Pursh) Kuntze
Potentilla anserina L.
Potentilla diversifolia Lehm.
Potentilla fruticosa L.
Potentilla gracilis Dougl. *ex* Hook.
Potentilla hyparctica Malte
Potentilla nivea L.
Potentilla norvegica L.
Potentilla palustris (L.) Scop.
Potentilla pensylvanica L.
Prunus virginiana L.
Rosa acicularis Lindl.
Rosa woodsii Lindl.
Rubus acaulis Michx. = *R. arcticus* L. ssp. *acaulis* (Michx.) Focke
Rubus idaeus L. = *R. strigosus* Michx.
Rubus parviflorus Nutt.
Rubus pedatus Smith
Rubus pubescens Raf.
Sibbaldia procumbens L.
Sorbus scopulina Greene
Spiraea lucida Dougl. = *Spiraea betulifolia* Pallas var. *lucida* (Dougl.) Hitchc.

RUBIACEAE

Galium boreale L.
Galium trifidum L.
Galium triflorum Michx.

SALICACEAE

Populus x brayshawii Boivin (*Populus angustifolia* James x *Populus balsamifera* L.)
Populus balsamifera L. ssp. *trichocarpa* (Torr. & Gray) Brayshaw
Populus tremuloides Michx.
Salix arctica Pallas
Salix barclayi Anders.
Salix barrattiana Hook.
Salix bebbiana Sarg.

Salix brachycarpa Nutt. ssp. *brachycarpa*
Salix candida Fleuge *ex* Willd.
Salix commutata Bebb
Salix drummondiana Barr. *ex* Hook.
Salix farriae Ball
Salix glauca L. var. *villosa* (Hook.) Anders.
Salix melanopsis Nutt.
Salix myrtillifolia Anders.
Salix nivalis Hook. = *S. reticulata* L. var. *nivalis* (Hook.) Anders.
Salix prolixa Anders.
Salix pseudomonticola Ball
Salix scouleriana Barr. *ex* Hook.
Salix vestita Pursh

SANTALACEAE

Commandra pallida A. DC.
Geocaulon lividum (Richards.) Fern.

SAXIFRAGACEAE

Heuchera cylindrica Dougl. *ex* Hook.
Leptarrhena pyrolifolia (Don) R. Br.
Lithophragma parviflora (Hook.) Nutt.
Mitella breweri Gray
Mitella nuda L.
Mitella pentandra Hook.
Mitella trifida Graham
Parnassia fimbriata Konig
Parnassia palustris L.
Parnassia parviflora DC.
Ribes hirtellum Michx.
Ribes hudsonianum Richards.
Ribes lacustre (Pers.) Poir.
Ribes laxiflorum Pursh
Ribes oxyacanthoides L.
Ribes viscosissimum Pursh
Saxifraga adscendens L.
Saxifraga aizoides L.
Saxifraga bronchialis L.
Saxifraga caespitosa L.
Saxifraga cernua L.
Saxifraga debilis Engelm. = *S. rivularis* L.
Saxifraga ferruginea Graham
Saxifraga lyallii Engl.
Saxifraga occidentalis Wats.
Saxifraga oppositifolia L.
Saxifraga rhomboidea Greene
Tiarella unifoliata Hook.

SCROPHULARIACEAE

Castilleja cervina Greenm.
Castilleja hispida Benth.
Castilleja miniata Dougl. *ex* Hook.
Castilleja occidentalis Torr.
Castilleja rhexifolia Rydb.

Castilleja septentrionalis Lindl. = *C. lutescens* (Greenm.) Rydb.
Collinsia parviflora Dougl.
Melampyrum lineare Desr.
Pedicularis bracteosa Benth.
Pedicularis contorta Benth.
Pedicularis racemosa Dougl.
Penstemon confertus Dougl.
Penstemon ellipticus Coult. & Fish.
Penstemon eriantherus Pursh
Penstemon fruticosus (Pursh) Greene
Veronica alpina L.
Veronica americana (Raf.) Schw.

UMBELLIFERAE

Cicuta maculata L. = *C. douglasii* (DC.) Coult. & Rose
Heracleum lanatum Michx.
Lomatium dissectum (Nutt.) Math. & Const.
Lomatium macrocarpum (Hook. & Arn.) Coult. & Rose
Lomatium triternatum (Pursh) Coult. & Rose
Osmorhiza chilensis Hook. & Arn.
Osmorhiza depauperata Phil.
Osmorhiza purpurea (Coult. & Rose) Suksd.
Sanicula marilandica L.

URTICACEAE

Urtica dioica L. ssp. *gracilis* (Ait.) Selander

VALERIANACEAE

Valeriana sitchensis Bong.

VIOLACEAE

Viola adunca J.E.Smith
Viola glabella Nutt.
Viola nephrophylla Greene
Viola orbiculata Geyer *ex* Hook.
Viola palustris L.
Viola renifolia Gray
Viola rugulosa Greene = *V. canadensis* L. var. *rugulosa* (Greene) Hitchc.

LILIATAE

CYPERACEAE

Carex aenea Fern.
Carex albo-nigra Mack.
Carex aquatilis Wahl.
Carex atherodes Spreng.
Carex atrosquama Mack.

Carex aurea Nutt.
Carex bebbi Olney *ex* Fern.
Carex brunnescens (Pers.) Poir.
Carex buxbaumii Wahl.
Carex capillaris L.
Carex concinna R.Br.
Carex concinnoides Mack.
Carex crawei Dewey
Carex deweyana Schw.
Carex diandra Schrank
Carex disperma Dewey
Carex eburnea Boott
Carex flava L.
Carex garberi Fern. var. *bifaria* Fern.
Carex gynocrates Wormskj.
Carex haydeniana Olney
Carex hoodii Boott
Carex interior Bailey
Carex lasiocarpa Ehrh.
Carex leptalea Wahl.
Carex limosa L.
Carex livida (Wahl.) Willd.
Carex macloviana D'Urv.
Carex microglochin Wahl.
Carex nardina Fries
Carex nigricans Meyer
Carex norvegica Retz.
Carex pachystachya Cham.
Carex paupercula Michx.
Carex petasata Dewey
Carex phaeocephala Piper
Carex physocarpa Presl. = *C. saxatilis* L.
Carex platylepis Mack.
Carex praticola Rydb.
Carex pyrenaica Wahl.
Carex raymondii Calder
Carex rossii Boott
Carex rostrata Stokes
Carex sartwellii Dewey
Carex scirpoidea Michx.
Carex scoparia Schk.
Carex spectabilis Dewey
Carex vaginata Tausch.
Eleocharis acicularis (L.) Roem. & Schul.
Eleocharis palustris (L.) Roem. & Schul.
Eleocharis quinqueflora (Hartm.) Schwartz
Eriophorum angustifolium Honck. = *E. polystachion* L.
Eriophorum chamissonis Meyer
Eriophorum viridi-carinatum (Engelm.) Fern.
Kobresia myosuroides (Vill.) Fiori & Paol = *K. bellardii* (All.) Degl.
Kobresia simpliciuscula (Wahl.) Mack.
Scirpus acutus Muhl. *ex* Bigel.
Scirpus caespitosus L.
Scirpus pumilis Vahl
Scirpus validus Vahl

GRAMINEAE

Agropyron pectiniforme Roem. & Schul.
Agropyron repens (L.) Beauv.
Agropyron spicatum (Pursh) Scribn. & Sm.

Agropyron trachycaulum (Link) Malte var. *trachycaulum*
Agropyron violaceum (Hornem.) Lange
Agrostis exarata Trin.
Agrostis scabra Willd.
Agrostis stolonifera L.
Agrostis variabilis Rydb.
Bromus carinatus Hook. & Arn. = *B. marginatus* Nees
Bromus ciliatus L.
Bromus inermis Leyss. ssp. *inermis*
Bromus inermis Leyss. ssp. *pumpellianus* (Scribn.) Wagnon
Bromus tectorum L.
Bromus vulgaris (Hook.) Shear
Calamagrostis canadensis (Michx.) Beauv.
Calamagrostis inexpansa Gray
Calamagrostis montanensis Scribn.
Calamagrostis purpurascens R. Br.
Calamagrostis rubescens Buckl.
Cinna latifolia (Trev.) Griseb.
Danthonia spicata (L.) Beauv.
Deschampsia atropurpurea (Wahl.) Scheele = *Vahlodea atropurpurea* (Wahl.) Fries
Deschampsia caespitosa (L.) Beauv.
Elymus glaucus Buckl.
Elymus innovatus Beal
Festuca baffinensis Polunin
Festuca campestris Rydb.
Festuca occidentalis Hook.
Festuca ovina L. var. *brachyphylla* (Schultes) Piper
Festuca rubra L.
Festuca scabrella Torr. = *F. altaica* Trin.
Glyceria elata (Nash) Hitchc.
Glyceria pulchella (Nash) Schum.
Glyceria striata (Lam.) Hitchc.
Hierochloe odorata (L.) Beauv.
Hordeum jubatum L.
Koeleria cristata (L.) Pers. = *K. macrantha* (Ledeb.) Schul.
Melica smithii (Porter) Vasey
Muhlenbergia glomerata (Willd.) Trin.
Oryzopsis asperifolia Michx.
Oryzopsis hymenoides (Roem. & Schul.) Ricker
Oryzopsis micrantha (Trin. & Rupr.) Thurb.
Oryzopsis pungens (Torr.) Hitchc.
Phleum alpinum L. = *P. commutatum* Gaudin
Phleum pratense L.
Poa alpina L.
Poa annua L.
Poa arctica R. Br.
Poa canbyi (Scribn.) Piper
Poa compressa L.
Poa epilis Scribn.
Poa interior L.
Poa leptocoma Trin.
Poa nervosa (Hook.) Vasey
Poa palustris L.
Poa pratensis L.
Poa rupicola Nash = *P. glauca* Vahl
Poa sandbergii Vasey
Poa stenantha Trin.
Schizachne purpurascens (Torr.) Swallen
Stipa columbiana Macoun
Stipa comata Trin. & Rupr.
Stipa richardsonii Link
Trisetum spicatum (L.) Richt.

IRIDACEAE

Sisyrinchium montanum Greene
Sisyrinchium sarmentosum Suksd. = *S. septentrionale* Bicknell

JUNCACEAE

Juncus alpinus Vill. = *J. alpinoarticulatus* Chaix
Juncus balticus Willd.
Juncus drummondii Meyer
Juncus dudleyi Wieg. = *J. tenuis* Willd. var. *dudleyi* (Wieg.) Herm.
Juncus hallii Engelm.
Juncus nodosus L.
Juncus parryi Engelm.
Juncus saximontanus Nels. = *J. ensifolius* Wikstr.
Juncus triglumis L. = *J. albescens* (Lange) Fern.
Luzula hitchcockii L. Hamet-Ahti = *L. glabrata* (Hoppe) Desv.
Luzula piperi (Cov.) Jones = *L. wahlenbergii* Rupr.
Luzula parviflora (Ehrh.) Desv.
Luzula spicata (L.) DC.

JUNCAGINACEAE

Triglochin maritima L.
Triglochin palustris L.

LILIACEAE

Allium cernuum Roth
Allium schoenoprasum L. var. *sibiricum* (L.) Hartm.
Calochortus macrocarpus Dougl.
Clintonia uniflora (Schult.) Kunth
Disporum trachycarpum (Wats.) Benth. & Hook.
Erythronium grandiflorum Pursh
Lilium philadelphicum L. var. *andinum* (Nutt.) Ker.
Smilacina racemosa (L.) Desf. var. *amplexicaulis* (Nutt.) Wats.
Smilacina stellata (L.) Desf.
Stenanthium occidentale Gray
Streptopus amplexifolius (L.) DC. var. *amplexifolius*
Streptopus roseus Michx. var. *curvipes* (Vail) Fassett
Tofieldia glutinosa (Michx.) Pers.
Tofieldia pusilla (Michx.) Pers.
Veratrum eschscholtzii Gray = *V. viride* Ait.
Zygadenus elegans Pursh
Zygadenus gramineus Rydb. = *Z. venenosus* Wats. var. *gramineus* (Rydb.) Walsh

ORCHIDACEAE

Calypso bulbosa (L.) Oakes
Corallorhiza maculata Raf.
Corallorhiza striata Lindl.
Corallorhiza trifida Chat.
Cypripedium montanum Dougl.
Cypripedium passerinum Richards.

Goodyera oblongifolia Raf.
Goodyera repens (L.) R. Br.
Habenaria dilatata (Pursh) Hook.
Habenaria hyperborea (L.) R. Br.
Habenaria obtusata (Pursh) Richards.
Habenaria orbiculata (Pursh) Torr.
Habenaria saccata Greene
Habenaria unalascensis (Spreng.) Wats.
Habenaria viridis (L.) R. Br. var. *bracteata* (Muhl.) Gray
Listera borealis Morong
Listera cordata (L.) R. Br.
Orchis rotundifolia Banks
Spiranthes romanzoffiana Cham. & Schlect.

POTAMOGETONACEAE

Potamogeton alpinus Balbis
Potamogeton berchtoldii Fieber = *P. pusillus* L.
Potamogeton gramineus L.
Potamogeton praelongus Wulf.

SPARGANIACEAE

Sparganium minimum (Hartm.) Fries

TYPHACEAE

Typha latifolia L.

LIVERWORTS

Anastrophyllum helleranum (Nees) Schust.
Barbilophozia hatcheri (Evans) Loeske
Barbilophozia lycopodioides (Wallr.) Loeske
Blepharostoma tricophyllum (L.) Dum.
Calypogeja muelleriana (Schiffn.) K.Muell.
Cephalozia biarspidata (L.) Dum.
Clevea hyalina (Somm.) Lindb. = *Athalamia hyalina* (Somm.) Hatt.
Geocalyx graveolens (Schrad.) Nees
Gymnomitrion concinnatum (Lightf.) Corda
Lepidozia reptans (L.) Dum.
Lophozia excisa (Dicks.) Dum.
Lophozia floerkii (Web. & Mohr) Schiffn.
Lophozia incisa (Schrad.) Dum.
Lophozia kunzeana (Hueb.) Evans
Lophozia longidens (Lindb.) Macoun
Lophosia obtusata (Lindb.) Evans
Lophozia porphyroleuca (Nees) Schiffn.
Lophozia ventricosa (Dicks.) Dum.
Lophozia wenzelii (Nees) Steph.
Marchantia polymorpha L.
Plagiochila asplenioides (L.) Dum.
Preissia quadrata (Scop.) Nees
Ptilidium californicum (Aust.) Underw.
Ptilidium pulcherrimum (G. Web.) Hampe

Scapania undulata (L.) Dum.
Tritomaria exsectiformis (Breidl.) Loeske
Tritomaria polita (Nees) Joerg.

MOSSES

Amblystegium serpens (Hedw.) B.S.G.
Atrichum selwynii Aust.
Aulacomnium androgynum (Hedw.) Schwaegr.
Aulacomnium palustre (Hedw.) Schwaegr.
Barbula acuta (Brid.) Brid.
Barbula convoluta Hedw.
Brachythecium albicans (Hedw.) B.S.G.
Brachythecium collinum (Schleich. *ex* C. Muell.) B.S.G.
Brachythecium curtum (Lindb.) Limpr.
Brachythecium groenlandicum (C. Jens.) Schljak.
Brachythecium hylotapetum B. Hig. & N. Hig.
Brachythecium leibergii Grout
Brachythecium populeum (Hedw.) B.S.G.
Brachythecium salebrosum (Web. & Mohr) B.S.G.
Brachythecium starkei (Brid.) B.S.G. = *B. curtum* (Lindb.) Limpr.
Brachythecium turgidum (C.J. Hartm.) Kindb.
Brachythecium velutinum (Hedw.) B.S.G.
Bryoerythrophyllum recurvirostrum (Hedw.) Chen
Bryum caespiticium Hedw.
Bryum cuspidatum (B.S.G.) Schimp. = *B. creberrimum* Tayl.
Bryum pallescens Schleich. *ex* Schwaegr.
Bryum pseudotriquetrum (Hedw.) Gaertn., Meyer & Schreb.
Bryum stirtonii Schimp.
Calliergon cordifolium B.S.G.
Calliergon giganteum (Schimp.) Kindb.
Calliergon trifarium (Web. & Mohr) Kindb.
Campylium chrysophyllum (Brid.) J. Lange
Campylium halleri (Hedw.) Lindb.
Campylium hispidulum (Brid.) Mitt.
Campylium stellatum (Hedw.) C. Jens.
Catoscopium nigritum (Hedw.) Brid.
Ceratodon purpureus (Hedw.) Brid.
Cratoneuron commutatum (Hedw.) Roth
Desmatodon latifolius (Hedw.) Brid.
Dicranoweisia crispula (Hedw.) Lindb. *ex* Milde
Dicranum acutifolium (Lindb. & Arnell) C. Jens *ex* Weinm.
Dicranum brevifolium Kindb.
Dicranum flagellare Hedw.
Dicranum fragilifolium Lindb.
Dicranum fuscescens Turn.
Dicranum muehlenbeckii B.S.G.
Dicranum pallidisetum (Bail. *ex* Holz.) Lindb.
Dicranum polysetum Sw.
Dicranum scoparium Hedw.
Dicranum spadiceum Zett.
Dicranum tauricum Sapeh.
Dicranum undulatum Brid.
Distichium capillaceum (Hedw.) B.S.G.
Ditrichum flexicaule (Schwaegr.) Hampe
Drepanocladus exannulatus (B.S.G.) Warnst.
Drepanocladus revolvens (Sw.) Warnst.
Drepanocladus uncinatus (Hedw.) Warnst.
Drepanocladus sendtneri (Schimp.) Warnst.
Drepanocladus uncinatus (Hedw.) Warnst.
Drepanocladus vernicosus (Lindb. *ex* C. Hartm.) Warnst.

Encalypta affinis R. Hedw.
Encalypta procera Bruch
Encalypta rhaptocarpa Schwaegr.
Eurhynchium pulchellum (Hedw.) Jenn.
Grimmia apocarpa Hedw.
Homalothecium aeneum (Mitt.) Lawt
Hylocomium pyrenaicum (Spruce) Lindb.
Hylocomium splendens (Hedw.) B.S.G.
Hypnum bambergeri Schimp.
Hypnum circinale Hook.
Hypnum cupressiforme Hedw.
Hypnum lindbergii Mitt.
Hypnum revolutum (Mitt.) Lindb.
Hypnum vaucheri Lesq.
Isopterygium pulchellum (Hedw.) Jaeg. & Sauerb.
Leptobryum pyriforme (Hedw.) Wils.
Lescuraea incurvata (Hedw.) Lawt.
Lescuraea radicosa (Mitt.) Moenk.
Mnium arizonicum Amann
Mnium blyttii B.S.G.
Mnium lycopodioides Schwaegr.
Mnium nudum Williams *ex* Britt. & Williams
Mnium spinulosum B.S.G.
Mnium thompsonii Schimp.
Orthothecium chryseum (Schwaegr. *ex* Schultes) B.S.G.
Orthotrichum obtusifolium Brid.
Orthotrichum pallens Bruch. *ex* Brid.
Pellia endiviifolia (Dicks.) Dum.
Philonotis fontana (Hedw.) Brid.
Plagiothecium denticulatum (Hedw.) B.S.G.
Plagiomnium ellipticum (Brid.) Koponen
Plagiomnium medium B.S.G.
Plagiothecium denticulatum (Hedw.) B.S.G.
Plagiothecium laetum B.S.G.
Platydictya jungermannioides (Brid.) Crum
Pleurozium schreberi (Brid.) Mitt.
Pogonatum alpinum (Hedw.) Roehl.
Pohlia cruda (Hedw.) Lindb.
Pohlia elongata Hedw.
Pohlia nutans (Hedw.) Lindb.
Pohlia proligera (Kindb. *ex* Limpr.) Lindb. *ex* Arnell
Pohlia wahlenbergii (Web. & Mohr) Andr.
Polytrichadelphus lyallii Mitt.
Polytrichum commune Hedw.
Polytrichum formosum Hedw.
Polytrichum juniperinum Hedw.
Polytrichum piliferum Hedw.
Polytrichum strictum Brid.
Pseudoleskea radicosa (Mitt.) Macoun & Kindb. var. *compacta* Best
Ptilium crista-castrensis (Hedw.) DeNot.
Pylaisiella polyantha (Hedw.) Grout
Rhacomitrium canescens (Hedw.) Brid.
Rhacomitrium heterostichum (Hedw.) Brid. var. *heterostichum*
Rhizomnium magnifolium (Horik.) Koponen
Rhizomnium nudum (Williams) Koponen
Rhizomnium pseudopunctatum (Bruch & Schimp.) Koponen
Rhytidiadelphus robusta (Hedw.) Broth.
Rhytidiadelphus triquetrus (Hedw.) Warnst.
Rhytidium rugosum (Hedw.) Kindb.
Roellia roellii (Broth. *ex* Roell) Andr. *ex* Crum
Scorpidium scorpioides (Hedw.) Limpr.
Scorpidium turgescens (T. Jens.) Loeske
Seligeria campylopoda Kindb.

Sphagnum fuscum (Schimp.) Klinggr.
Sphagnum nemoreum Scop.
Sphagnum subsecundum Nees *ex* Sturm.
Sphagnum warnstorfii Russ.
Tetraphis pellucida Hedw.
Thuidium abietinum (Hedw.) B.S.G.
Thuidium recognitum (Hedw.) Lindb.
Timmia austriaca Hedw.
Timmia megapolitana Hedw.
Tomenthypnum nitens (Hedw.) Loeske
Tortella fragilis (Drumm.) Limpr.
Tortella inclinata (R. Hedw.) Limpr.
Tortella tortuosa (Hedw.) Limpr.
Tortula norvegica (Web.) Wahlenb. *ex* Lindb.
Tortula ruralis (Hedw.) Gaertn., Meyer & Schreb.

LICHENS

Acarospora chlorophana (Wahlenb. *ex* Ach.) Mass.
Acarospora heppii (Naeg.) Naeg.
Alectoria sarmentosa (Ach.) Ach.
Aspicilia albopruinosa Loom.
Aspicilia caesiocinerea (Nyl. *ex* Malbr.) Arn.
Bacidia obscurata (Somm.) Zahlbr.
Baeomyces rufus (Huds.) Rebent.
Bryoria abbreviata (Muell. Arg.) Brodo & D. Hawksw.
Bryoria capillaris (Ach.) Brodo & D. Hawksw.
Bryoria fremontii (Tuck.) Brodo & D. Hawksw.
Bryoria fuscescens (Gyeln.) Brodo & D. Hawksw.
Bryoria glabra (Mot.) Brodo & D. Hawksw.
Bryoria lanestris (Ach.) Brodo & D. Hawksw.
Bryoria oregana (Tuck.) Brodo & D. Hawksw.
Bryoria pseudofuscescens (Gyeln) Brodo & D. Hawksw.
Buellia triphragmioides Anzi
Calicium salicinum Pers.
Calicium viride Pers.
Caloplaca holocarpa (Hoffm.) Wade
Caloplaca jungermanniae (Vahl) Th. Fr.
Caloplaca saxicola (Hoffm.) Nordin
Caloplaca sinapisperma (Lam.) Mah. & Gill.
Candelaria concolor (Dicks.) B. Stein
Cetraria canadensis (Raes.) Raes.
Cetraria chlorophylla (Willd.) Vain.
Cetraria cucullata (Bell.) Ach.
Cetraria ericetorum Opiz
Cetraria islandica (L.) Ach.
Cetraria merrillii DuRietz
Cetraria nivalis (L.) Ach.
Cetraria pinastri (Scop.) S.Gray
Cetraria platyphylla Tuck.
Cetraria subalpina Imsh.
Cetraria tilesii Ach.
Cladonia arbuscula (Wallr.)
Cladonia bacillaris (Ach.) Nyl.
Cladonia botrytes (Hag.) Willd.
Cladonia cariosa (Ach.) Spreng.
Cladonia carneola (Fr.) Fr.
Cladonia cenotea (Ach.) Schaer.
Cladonia cervicornis (Ach.) Flot. ssp. *verticillata* (Hoffm.) Ahti
Cladonia chlorophaea (Floerke *ex* Somm.) Spreng.
Cladonia coccifera (L.) Willd.

Cladonia coniocraea (Floerke) Spreng
Cladonia cornuta (L.) Hoffm.
Cladonia crispata (Ach.) Flot.
Cladonia deformis (L.) Hoffm.
Cladonia ecmocyna (Ach.) Nyl.
Cladonia fimbriata (L.) Fr.
Cladonia furcata (Huds.) Schrad.
Cladonia gracilis (L.) Willd.
Cladonia mitis Sandst.
Cladonia multiformis Merr.
Cladonia phyllophora Ehrh. *ex* Hoffm.
Cladonia pleurota (Floerke) Schaer.
Cladonia pocillum (Ach.) O. Rich.
Cladonia polydactyla (Floerke) Spreng.
Cladonia pyxidata (L.) Hoffm.
Cladonia robbinsii Evans
Cladonia subulata (L.) Wigg.
Cladonia sulphurina (Michx.) Fr.
Coelocaulon aculeatum (Schreb.) Link
Coniocybe furfuracea (L.) Ach.
Dactylina ramulosa (Hook.) Tuck.
Dermatocarpon weberi (Ach.) Mann.
Diploschistes scruposus (Schreb.) Norm.
Evernia divaricata (L.) Ach.
Hypocenomyce scalaris (Ach.) Choisy
Hypogymnia austerodes (Nyl.) Raes.
Hypogymnia enteromorpha (Ach.) Nyl.
Hypogymnia imshaugii Krog
Hypogymnia physodes (L.) Nyl.
Hypogymnia tubulosa (Schaer.) Hav.
Icmadophila ericetorum (L.) Zahlbr.
Lecanora coilocarpa (Ach.) Nyl.
Lecanora epibyron (Ach.) Ach.
Lecanora melanophthalma (Ram.) Ram.
Lecanora polytropa (Hoffm.) Rabenh.
Lecanora rupicola (L.) Zahlbr.
Lecidea berengeriana (Mass.) Nyl.
Lecidea cinnabarina Somm.
Lecidea fuscescens Somm.
Lecidea granulosa (Hoffm.) Ach.
Lecidea lapicida (Ach.) Ach.
Lecidea nigrocruenta Anzi
Lecidea tornoensis Nyl.
Lepraria incana (L.) Ach.
Lepraria membranacea (Dicks.) Vain.
Lepraria neglecta (Nyl.) Lett.
Leptogium burnetiae var. *hirsutum* (Sierk) P.M. Jorg.
Letharia columbiana (Nutt.) Thoms.
Letharia vulpina (L.) Hue
Lobaria pulmonaria (L.) Hoffm.
Mycoblastus affinis (Schaer.) Schauer
Mycoblastus sanguinarius (L.) Norman
Nephroma arcticum (L.) Torss.
Nephroma bellum (Spreng.) Tuck.
Nephroma expallidum (Nyl.) Nyl.
Nephroma helveticum Ach.
Nephroma parile (Ach.) Ach.
Nephroma resupinatum (L.) Ach.
Ochrolechia inaequatula (Nyl.) Zahlbr.
Pachyospora verrucosa (Ach.) Mass
Pannaria pezizoides (G. Web.) Trev.
Parmelia exasperatula Nyl.
Parmelia sphaerosporella Muell. Arg.

Parmelia subolivacea Nyl.
Parmelia sulcata Tayl.
Parmeliopsis aleurites (Ach.) Nyl.
Parmeliopsis ambigua (Wulf.) Nyl.
Parmeliopsis hyperopta (Ach.) Arn.
Peltigera aphthosa (L.) Willd.
Peltigera canina (L.) Willd.
Peltigera elizabethae Gyeln.
Peltigera horizontalis (Huds.) Baumg.
Peltigera malacea (Ach.) Funck
Peltigera polydactyla (Neck.) Hoffm.
Peltigera rufescens (Weis.) Humb
Peltigera spuria (Ach.) DC.
Peltigera venosa (L.) Hoffm.
Pertusaria ophthalmiza (Nyl.) Nyl.
Physcia aipolia (Ehrh. *ex* Humb.) Fuernrohr
Platismatia glauca (L.) W. Culb. & C. Culb.
Psora decipiens (Hedw.) Hoffm.
Psora rubiformis (Ach.) Hook.
Psoroma hypnorum (Vahl) S. Gray
Ramalina pollinaria (Westr.) Ach.
Rhizocarpon geographicum (L.) DC.
Rhizocarpon macrosporum Raes.
Rhizocarpon riparium Raes.
Rinodina roscida (Somm.) Arn.
Rinodina turfacea (Wahl.) Koerb.
Solorina bispora Nyl.
Solorina crocea (L.) Ach.
Solorina octospora Arn.
Solorina saccata (L.) Ach.
Solorina spongiosa (Sm.) Anzi
Sphaerophorus globosus (Huds.) Vain.
Stereocaulon alpinum Laur.
Stereocaulon tomentosum Fr.
Thamnolia subuliformis (Ehrh.) W. Culb.
Toninia caeruleonigricans (Lightf.) Th. Fr.
Umbilicaria deusta (L.) Baumg.
Umbilicaria hyperborea (Ach.) Hoffm.
Umbilicaria krascheninnikovii (Sav.) Schol.
Umbilicaria virginis Schaer.
Usnea alpina Mot.
Usnea cavernosa Tuck.
Usnea glabrescens (Nyl. *ex* Vain.) Vain.
Usnea scabrata Nyl.
Usnea sorediifera (Arn.) Lynge = *U. fulvoreagens* (Raes.) Raes.
Usnea subfloridana Stirt.
Verrucaria muralis Ach.
Verrucaria virens Nyl.
Xanthoria elegans (Link) Th. Fr.
Xanthoria fallax (Hepp) Arn.

APPENDIX B - ANIMALS OF KOOTENAY NATIONAL PARK

INTRODUCTION

Nomenclature for this checklist is based on Stebbins (1966), American Ornithologists' Union (1982), and Banfield (1974). Records are based on observations made by the wildlife crew during the ecological land classification and information in the Warden Service and Interpretive Service files at KNP. Further details are in Poll *et al.* (1984). Names in brackets are hypothetical species for which there is no verified record for the park. KNP has a total of 4 amphibian species, 2 reptile species (plus one hypothetical), 182 bird species (plus 9 hypothetical), and 58 mammal species.

AMPHIBIANS

Long-toed salamander *Ambystoma macrodactylum*
Western toad *Bufo boreas*
Wood frog *Rana sylvatica*
Spotted frog *Rana pretiosa*

REPTILES

Rubber boa *Charina bottae*
[Common (red-sided) garter snake *Thamnophis sirtalis parietalis*]
Western terrestrial (wandering) garter snake *Thamnophis elegans vagrans*

BIRDS

Common Loon *Gavia immer* (Brünnich)
Pied-billed Grebe *Podilymbus podiceps* (Linnaeus)
Horned Grebe *Podiceps auritus* (Linnaeus)
Red-necked Grebe *Podiceps grisegena* (Boddaert)
Eared Grebe *Podiceps nigricollis* Brehm
Western Grebe *Aechmophorus occidentalis* (Lawrence)
Great Blue Heron *Ardea herodias* Linnaeus
Tundra Swan *Cygnus columbianus* (Ord)
[Trumpeter Swan *Cygnus buccinator* (Richardson)]
Snow Goose *Chen caerulescens* (Linnaeus)
Canada Goose *Branta canadensis* (Linnaeus)
Green-winged Teal *Anas crecca* Linnaeus
Mallard *Anas platyrhynchos* Linnaeus
Northern Pintail *Anas acuta* Linnaeus
Blue-winged Teal *Anas discors* Linnaeus
Cinnamon Teal *Anas cyanoptera* Vieillot
Northern Shoveler *Anas clypeata* Linnaeus
American Wigeon *Anas americana* Gmelin
Redhead *Aythya americana* (Eyton)
Ring-necked Duck *Aythya collaris* (Donovan)
Lesser Scaup *Aythya affinis* (Eyton)
Harlequin Duck *Histrionicus histrionicus* (Linnaeus)
Surf Scoter *Melanitta perspicillata* (Linnaeus)
White-winged Scoter *Melanitta fusca* (Linnaeus)
Common Goldeneye *Bucephala clangula* (Linnaeus)
Barrow's Goldeneye *Bucephala islandica* (Gmelin)

Bufflehead *Bucephala albeola* (Linnaeus)
Hooded Merganser *Lophodytes cucullatus* (Linnaeus)
Common Merganser *Mergus merganser* Linnaeus
Red-breasted Merganser *Mergus serrator* Linnaeus
Ruddy Duck *Oxyura jamaicensis* (Gmelin)
Osprey *Pandion haliaetus* (Linnaeus)
Bald Eagle *Haliaeetus leucocephalus* (Linnaeus)
Northern Harrier *Circus cyaneus* (Linnaeus)
Sharp-shinned Hawk *Accipiter striatus* Vieillot
Cooper's Hawk *Accipiter cooperii* (Bonaparte)
Northern Goshawk *Accipiter gentilis* (Linnaeus)
Swainson's Hawk *Buteo swainsoni* Bonaparte
Red-tailed Hawk *Buteo jamaicensis* (Gmelin)
Rough-legged Hawk *Buteo lagopus* (Pontoppidan)
Golden Eagle *Aquila chrysaetos* (Linnaeus)
American Kestrel *Falco sparverius* Linnaeus
Merlin *Falco columbarius* Linnaeus
[Prairie Falcon *Falco mexicanus* Schlegel]
Spruce Grouse *Dendragapus canadensis* (Linnaeus)
Blue Grouse *Dendragapus obscurus* (Say)
White-tailed Ptarmigan *Lagopus leucurus* (Richardson)
Ruffed Grouse *Bonasa umbellus* (Linnaeus)
Sora *Porzana carolina* (Linnaeus)
American Coot *Fulica americana* Gmelin
[Sandhill Crane *Grus canadensis* (Linnaeus)]
Killdeer *Charadrius vociferus* Linnaeus
[Greater Yellowlegs *Tringa melanoleuca* (Gmelin)]
Lesser Yellowlegs *Tringa flavipes* (Gmelin)
Solitary Sandpiper *Tringa solitaria* Wilson
Spotted Sandpiper *Actitis macularia* (Linnaeus)
Least Sandpiper *Calidris minutilla* (Vieillot)
Baird's Sandpiper *Calidris bairdii* (Coues)
[Short-billed Dowitcher *Limnodromus griseus* (Gmelin)]
Common Snipe *Gallinago gallinago* (Linnaeus)
Wilson's Phalarope *Phalaropus tricolor* (Vieillot)
Red-necked Phalarope *Phalaropus lobatus* (Linnaeus)
Long-tailed Jaeger *Stercorarius longicaudus* Vieillot
Bonaparte's Gull *Larus philadelphia* (Ord)
Mew Gull *Larus canus* Linnaeus
Ring-billed Gull *Larus delawarensis* Ord
California Gull *Larus californicus* Lawrence
Rock Dove *Columba livia* Gmelin
Mourning Dove *Zenaida macroura* (Linnaeus)
[Flammulated Owl *Otus flammeolus* (Kaup)]
Western Screech-Owl *Otus kennicottii* (Elliot)
Great Horned Owl *Bubo virginianus* (Gmelin)
Northern Hawk-Owl *Surnia ulula* (Linnaeus)
Northern Pygmy-Owl *Glaucidium gnoma* Wagler
Barred Owl *Strix varia* Barton
Great Gray Owl *Strix nebulosa* Forster
Short-eared Owl *Asio flammeus* (Pontoppidan)
Boreal Owl *Aegolius funereus* (Linnaeus)
Northern Saw-whet Owl *Aegolius acadicus* (Gmelin)
Common Nighthawk *Chordeiles minor* (Forster)
Black Swift *Cypseloides niger* (Gmelin)
Vaux's Swift *Chaetura vauxi* (Townsend)
[Black-chinned Hummingbird *Archilochus alexandri* (Bourcier & Mulsant)]
Calliope Hummingbird *Stellula calliope* (Gould)
Rufous Hummingbird *Selasphorus rufus* (Gmelin)
Belted Kingfisher *Ceryle alcyon* (Linnaeus)
Yellow-bellied Sapsucker *Sphyrapicus varius* (Linnaeus)
Downy Woodpecker *Picoides pubescens* (Linnaeus)
Hairy Woodpecker *Picoides villosus* (Linnaeus)

Three-toed Woodpecker *Picoides tridactylus* (Linnaeus)
Black-backed Woodpecker *Picoides arcticus* (Swainson)
Northern Flicker *Colaptes auratus* (Linnaeus)
Pileated Woodpecker *Dryocopus pileatus* (Linnaeus)
Olive-sided Flycatcher *Contopus borealis* (Swainson)
Western Wood Pewee *Contopus sordidulus* Sclater
Alder Flycatcher *Empidonax alnorum* Brewster
Willow Flycatcher *Emipdonax traillii* (Audubon)
Least Flycatcher *Empidonax minimus* (Baird & Baird)
Hammond's Flycatcher *Empidonax hammondii* (Xantus de Vesey)
Dusky Flycatcher *Empidonax oberholseri* Phillips
Western Flycatcher *Empidonax difficilis* Baird
Western Kingbird *Tyrannus verticalis* Say
Eastern Kingbird *Tyrannus tyrannus* (Linnaeus)
Horned Lark *Eremophila alpestris* (Linnaeus)
Tree Swallow *Tachycineta bicolor* (Vieillot)
Violet-green Swallow *Tachycineta thalassina* (Swainson)
Northern Rough-winged Swallow *Stelgidopteryx serripennis* (Audubon)
Bank Swallow *Riparia reparia* (Linnaeus)
Cliff Swallow *Hirundo pyrrhonota* Vieillot
Barn Swallow *Hirundo rustica* Linnaeus
Gray Jay *Perisoreus canadensis* (Linnaeus)
Steller's Jay *Cyanocitta stelleri* (Gmelin)
Clark's Nutcracker *Nucifraga columbiana* (Wilson)
Black-billed Magpie *Pica pica* (Linnaeus)
American Crow *Corvus brachyrhynchos* Brehm
Common Raven *Corvus corax* Linnaeus
Black-capped Chickadee *Parus atricapillus* Linnaeus
Mountain Chickadee *Parus gambeli* Ridgway
Boreal Chickadee *Parus hudsonicus* Forster
Red-breasted Nuthatch *Sitta canadensis* Linnaeus
White-breasted Nuthatch *Sitta carolinensis* Latham
Brown Creeper *Certhia americana* Bonaparte
Rock Wren *Salpinctes obsoletus* (Say)
Winter Wren *Troglodytes troglodytes* (Linnaeus)
American Dipper *Cinclus mexicanus* Swainson
Golden-crowned Kinglet *Regulus satrapa* Lichtenstein
Ruby-crowned Kinglet *Regulus calendula* (Linnaeus)
Mountain Bluebird *Sialia currucoides* (Bechstein)
Townsend's Solitaire *Myadestes townsendi* (Audubon)
[Veery *Catharus fuscesens* (Stephens)]
Swainson's Thrush *Catharus ustulatus* (Nuttall)
Hermit Thrush *Catharus guttatus* (Pallas)
American Robin *Turdus migratorius* Linnaeus
Varied Thrush *Ixoreus naevius* (Gmelin)
Water Pipit *Anthus spinoletta* (Linnaeus)
Bohemian Waxwing *Bombycilla garrulus* (Linnaeus)
Cedar Waxwing *Bombycilla cedrorum* Vieillot
Northern Shrike *Lanius excubitor* Linnaeus
[Loggerhead Shrike *Lanius ludovicianus* Linnaeus]
European Starling *Sturnus vulgaris* Linnaeus
Solitary Vireo *Vireo solitarius* (Wilson)
Warbling Vireo *Vireo gilvus* (Vieillot)
Red-eyed Vireo *Vireo olivaceus* (Linnaeus)
Tennessee Warbler *Vermivora peregrina* (Wilson)
Orange-crowned Warbler *Vermivora celata* (Say)
Yellow Warbler *Dendroica petechia* (Linnaeus)
Magnolia Warbler *Dendrioca magnolia* (Wilson)
Cape May Warbler *Dendroica tigrina* (Gmelin)
Yellow-rumped Warbler *Dendroica coronata* (Linnaeus)
Townsend's Warbler *Dendroica townsendi* (Townsend)
Blackpoll Warbler *Dendroica striata* (Forster)
American Redstart *Setophaga ruticilla* (Linnaeus)

Northern Waterthrush ***Seiurus noveboracensis*** (Gmelin)
MacGillivray's Warbler ***Oporornis tolmiei*** (Townsend)
Common Yellowthroat ***Geothlypis trichas*** (Linnaeus)
Wilson's Warbler ***Wilsonia pusilla*** (Wilson)
Western Tanager ***Piranga ludoviciana*** (Wilson)
Black-headed Grosbeak ***Pheucticus melanocephalus*** (Swainson)
Lazuli Bunting ***Passerina amoena*** (Say)
Chipping Sparrow ***Spizella passerina*** (Bechstein)
Clay-colored Sparrow ***Spizella pallida*** (Swainson)
Brewer's Sparrow ***Spizella breweri*** Cassin
Vesper Sparrow ***Pooecetes gramineus*** (Gmelin)
Lark Bunting ***Calamospiza melanocorys*** Stejneger
Savannah Sparrow ***Passerculus sandwichensis*** (Gmelin)
Le Conte's Sparrow ***Ammodramus leconteii*** (Audubon)
Fox Sparrow ***Passerella iliaca*** (Merrem)
Song Sparrow ***Melospiza melodia*** (Wilson)
Lincoln's Sparrow ***Melospiza lincolnii*** (Audubon)
Golden-crowned Sparrow ***Zonotrichia atricapilla*** (Gmelin)
White-crowned Sparrow ***Zonotrichia albicollis*** (Forster)
Dark-eyed Junco ***Junco hyemalis*** (Linnaeus)
Snow Bunting ***Plectrophenax nivalis*** (Linnaeus)
Red-winged Blackbird ***Agelaius phoeniceus*** (Linnaeus)
Western Meadowlark ***Sturnella neglecta*** Audubon
Yellow-headed Blackbird ***Xanthocephalus xanthocephalus*** (Bonaparte)
Rusty Blackbird ***Euphagus carolinus*** (Muller)
Brewer's Blackbird ***Euphagus cyanocephalus*** (Wagler)
Brown-headed Cowbird ***Molothrus ater*** (Boddaert)
Rosy Finch ***Leucosticte arctoa*** (Pallas)
Pine Grosbeak ***Pinicola enucleator*** (Linnaeus)
Purple Finch ***Carpodacus purpureus*** (Gmelin)
Cassin's Finch ***Carpodacus casinii*** Baird
Red Crossbill ***Loxia curvirostra*** Linnaeus
White-winged Crossbill ***Loxia leucoptera*** Gmelin
Common Redpoll ***Carduelis flammea*** (Wilson)
Pine Siskin ***Carduelis pinus*** (Wilson)
American Goldfinch ***Carduelis tristis*** (Linnaeus)
Evening Grosbeak ***Coccothraustes vespertinus*** (Cooper)
House Sparrow ***Passer domesticus*** (Linnaeus)

MAMMALS

Masked shrew ***Sorex cinereus*** Kerr
Dusky shrew ***Sorex monticolus*** (Merriam)
Water shrew ***Sorex palustris*** Richardson
Pygmy shrew ***Sorex hoyi*** (Baird)
Little brown bat ***Myotis lucifugus*** (Le Conte)
Northern long-eared bat ***Myotis septentrionalis*** Merriam
Long-eared bat ***Myotis evotis*** (H. Allen)
California bat ***Myotis californicus*** (Audubon & Bachman)
Silver-haired bat ***Lasionycteris noctivagans*** (Le Conte)
Big brown bat ***Eptesicus fuscus*** (Palisot de Beauvois)
Hoary bat ***Lasiurus cinereus*** (Palisot de Beauvois)
American pika ***Ochotona princeps*** (Richardson)
Snowshoe hare ***Lepus americanus*** Erxleben
Least chipmunk ***Eutamias minimus*** (Bachman)
Yellow-pine chipmunk ***Eutamias amoenus*** (J.A. Allen)
Woodchuck ***Marmota monax*** (Linnaeus)
Hoary marmot ***Marmota caligata*** (Eschscholtz)
Columbian ground squirrel ***Spermophilus columbianus*** (Ord)
Golden-mantled ground squirrel ***Spermophilus lateralis*** (Say)

Red squirrel *Tamiasciurus hudsonicus* (Erxleben)
Northern flying squirrel *Glaucomys sabrinus* (Shaw)
Beaver *Castor canadensis* Kuhl
Deer mouse *Peromyscus maniculatus* (Wagner)
Bushy-tailed wood rat *Neotoma cinerea* (Ord)
Gapper's red-backed vole *Clethrionomys gapperi* (Vigors)
Northern bog lemming *Synaptomys borealis* (Richardson)
Heather vole *Phenacomys intermedius* Merriam
Muskrat *Ondatra zibethicus* (Linnaeus)
Richardson's water vole *Arvicola richardsoni* DeKay
Meadow vole *Microtus pennsylvanicus* (Ord)
Long-tailed vole *Microtus longicaudus* (Merriam)
Western jumping mouse *Zapus princeps* J.A. Allen
Porcupine *Erethizon dorsatum* (Linnaeus)
Coyote *Canis latrans* Say
Wolf *Canis lupus* Linnaeus
Red fox *Vulpes vulpes* (Linnaeus)
Black bear *Ursus americanus* Pallas
Grizzly bear *Ursus arctos* Linnaeus
Marten *Martes americana* (Turton)
Fisher *Martes pennanti* (Erxleben)
Short-tailed weasel *Mustela erminea* Linnaeus
[Long-tailed weasel *Mustela frenata* Lichtenstein]
Mink *Mustela vison* Schreber
Wolverine *Gulo gulo* (Linnaeus)
Badger *Taxidea taxus* (Schreber)
Striped skunk *Mephitis mephitis* (Schreber)
River otter *Lontra canadensis* (Schreber)
Cougar *Felis concolor* Linnaeus
Canada lynx *Lynx lynx* (Linnaeus)
Bobcat *Lynx rufus* (Schreber)
Mule deer *Odocoileus hemionus* (Rafinesque)
White-tailed deer *Odocoileus virginianus* (Zimmermann)
Moose *Alces alces* (Linnaeus)
Elk *Cervus elaphus* Linnaeus
Mountain goat *Oreamnos americanus* (de Blainville)
Bighorn sheep *Ovis canadensis* Shaw

APPENDIX C - CORRELATION OF MAP UNITS

Three nearby land inventories were compared with the KNP Ecological Land Classification to correlate map units or concepts. The inventories are: *Soil resources of the Lardeau Map Area* (Wittneben 1980), *Soils of the East Kootenay Map Area* (Lacelle 1982, manuscript maps and legend only), and *Biophysical (ecological) inventory of Yoho National Park* (Coen and Kuchar 1982). Listed below are map units or groups of map units that correspond most closely to KNP Ecosites. Similarity was evaluated on a conceptual basis first and on a map polygon basis second. The landscape components were evaluated in the following order.

1. Ecoregion and Ecoregion subdivision *vs*. forest zone or subzone.

2. Landform and parent materials.

3. Soil classification.

4. Vegetation type or grouping.

The following symbols and conventions are used in the list below.

Virgule (/): one of two things in descending order of use:

a. One Ecoregion or subdivision in KNP often corresponds to parts of two forest zones or subzones in the soil inventories of the East Kootenay and Lardeau areas. Therefore, one Ecosite corresponds to parts of two soil associations or their components, one from each forest zone or subzone, and a virgule separates the two in the table.

b. Occasionally, soil associations differentiated by bedrock lithology were regrouped, but separated by a virgule, opposite one KNP Ecosite.

Plus (+) and greater than (>): a combination of soil associations or soil association components which best correspond to a KNP Ecosite.

Asterisk (*): soil taxonomic differences, at the great group level (C.S.S.C. 1978a), except Dystric *vs*. Eutric Brunisol or one member of a pair of codominant soils is significantly different.

Double asterisk (**): soil taxonomic differences at the order level (C.S.S.C. 1978a) or the great group level when distinguishing Dystric from Eutric Brunisols. Differences in soil taxonomy are due largely to the use of older versions of the Canadian soil classification system by the other inventories.

Dagger(†): significant vegetation differences. For example, RA1 (Wittneben 1980) was grouped in the Alpine tundra zone which in KNP includes the Upper Subalpine-Alpine ecotone; TA-SF (Coen and Kuchar 1982) is characterized by Engelmann spruce and subalpine fir but includes areas with lodgepole pine which correspond to the BV2 Ecosite in KNP.

Variant (var): A KNP Ecosite corresponds to a variant in YNP (Coen and Kuchar 1982).

KNP	East Kootenay[1]	Lardeau	Yoho
AL3	FP**/GE**	—	CO-SF
AL4	FP**/GE**	—	—
AT1	KE/GB	KE1	TA-P
AT4	KE/GB	KE1	TA-DSP†
BP2	—	—	SI-aL(LS)
BS1	RJ*	RA1*†	OO-H**
BS2	RJ*	RA2*†	OO-H**
BV2	GB	—	TA-SF*†
BY1	SP/MC**	SP1	OG-SF*
BY3	SP/MC**	SP1	—
BY4	GB+SP	—+SP1	—
BY5	SP/MC**	SP1	—
BY6	SP/MC**	SP3	OG-SF*
BY7	GB+SP	—+SP1	—
CA1	ME** or MW**>OD** or ON**	—	—
CA2	ME**/MW**	—	CM-SF*
CA4	ME**/MW**	—	—
CV1	—	—	OL-SF*
DG1	CR/CK/CW	CR1	FL-D
DG3	BF**/RI**/BS**	BF2**	BG-DN or R-F(D)
DG6	CR/CK/CW	CR1	FL-PD
DR1	CD	KB2**	OL-D
DR2	CD	KB2**	OL-P
DR3	CD	KB2**	OL-SPD†
DR4	CD	KB2**	CM-TS or OL-PT†
DR5	CD	KB2**	—
DR6	CD+KE>OS**	KB2**+KE4>O**	—
DR7	KE+CD	KE4+KB2**	—
DR8	CD+KE>OS**	KB2**+KE4>O**	—
EF1	—	—	SK-Hvar**
EG1	ME**	—	—
EG2	ME**	—	—
EG3	ME**>—	—	—
EG4	ME**/MP**	—	—
EN3	BP**	BP4/5**	—
FR1	MA**	FA1	—
FR3	MA**	FA1	CO-SDP†
FV3	CT/CZ**	CB3	—
FV4	RU/RK**	BB5+3	—

KNP	East Kootenay[1]	Lardeau	Yoho
FV5	CT/CZ**	CB3	—
FV6	CT/CZ**	CB3	—
HC1	FV*/FJ*	—	BC-Se*†
HD5	FF/FU	NW1	WR-SPDT†
HD6	FF* + NW*	NW2	WR-GSd†
HE2	RO	RO	R + H
IB4	—	—	BG-SF(LS)**
JN1	—	—	—
LV2	MN**/MP**	—	OD-Fvar**
LV3	MN**	—	OD-Fvar**†
PL1	MC**	—	OD-F**†
PL4	MC**/MP**	—	OD-F**
PL6	MC**	—	OD-F**†
PP3	FU/—	—	WR-SF or KI-SF
PP4	FU/—	—	—
RD2	—	—	—
SB1	CW/CM**	CW1	BG-A*
SB2	CW/CM**	CW1	FL-SF*
SB3	CW/CM**	CW1	—
SB4	BS/RT**	BS3 + 1	R-F
SB6	CW/CM**	CW3 or BS2	FL-SF*
SB7	CW/CM**	CW3 or BS2	—
SX1	—	—	—
SX2	—	—	—
TK1	—	—	—
VL2	OS**/ON**	O**	BC-w*†
VL6	OS**/ON**	O**	BC-Se*†
WF1	CM**/COY**	RA1*/CW1	SI-F**†
WF2	CM**/COY**	RA1*/CW1	SI-F**†
WF3	RT**/RA**	RA1*/BS3 + 1	SI-whP** or R-whP,R-F
WF5	CM**/COY**	RA2*/CW3	SI-F**†
WF6	CM**/COY**	RA2*/CW3	SI-F**†
WH1	CZ**/COY**	RA1**/CB1	—
WH4	RK**/RA**	RA1**/BB5/3	—
WH6	CZ**/COY**	RA1**/CB3	—
WH7	CZ**/COY**	RA1**/CB3	—
WH8	CZ**/COY**	RA1**/CB3	—
WY1	WY1	WY1	—
WY2	WY2	WY3	—

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[1] Soil association components provided in one case where known.

APPENDIX D - PEDON DESCRIPTIONS AND ANALYTICAL DATA

Appendix D contains descriptions and analytical data of 35 pedons chosen to represent soils of selected Ecosites and Ecosections. The tables are arranged alphanumerically by Ecosite symbol. The table title includes the Provincial Identification Number (*e.g.* Alberta 1982 No. 970) by which the pedon information can by accessed in the Canada Soil Information System (CanSIS), Agriculture Canada, Ottawa.

Table D1. Pedon (Alberta 1982 No. 970) describing an Eluviated Eutric Brunisol of the AL4 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ELUVIATED EUTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: AL4.

LOCATION: MILITARY GRID REF. 11 UNG 6710 5920; NTS MAP AREA 82H 1*.

CLIMATE: 1380 METERS ABOVE MEAN SEA LEVEL. STATION AT KOOTENAY XING HAS MODERATE RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 5 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VPN=PA2042*VTN=C14*..

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND STRATIFIED (MINERAL), MODERATELY TO VERY STRONGLY CALCAREOUS (6-40% CACO3), FLUVIAL, MIXED AND LIMESTONE AND SLATE; LANDFORM CLASSIFICATION: INACTIVE FLUVIAL, APRON; SLOPE: 13% SIMPLE SLOPE OF CLASS 5 (10-15%), FACING SOUTHWEST, SITE AT MIDDLE POSITION, SLIGHTLY MOUNDED MICROTOPOGRAPHY,300 M LONG; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, SLOW SURFACE RUNOFF, SEEPAGE ABSENT; NONSTONY; NONROCKY; PRESENT LAND USE: OUTDOOR RECREATION.

SPECIAL NOTES: SSN=BW2153*APN=BC5391-056*PH=5.8(5)AT 27 CM*EOLIAN INFLUENCE,IN UPPER SOLUM,MIXING IN B HORIZONS*TILL-LIKE MUD FLOW MATERIAL IN LOWER SOLUM*DATE=82/09/26*

LFH: 3 TO 0 CM, RANGE 2 TO 7 CM; MATRIX MOIST 10YR 2/2; ABUNDANT, FINE AND MEDIUM AND COARSE ROOTS; WAVY, ABRUPT HORIZON BOUNDARY.

AE: 0 TO 2 CM, RANGE 0 TO 6 CM; MATRIX MOIST 10YR 6/3.5, MATRIX MOIST 2.5YR 5/4; SILT; VERY WEAK, MEDIUM, PLATY STRUCTURE; VERY WEAK, FINE, SUBANGULAR BLOCKY SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, VERY FINE AND FINE ROOTS; VERY FEW, MICRO PORES; 10% GRAVELLY AND ANGULAR GRAVELLY AND SLATY COARSE FRAGMENTS; BROKEN, ABRUPT HORIZON BOUNDARY.

BFU: 2 TO 6 CM, RANGE 0 TO 8 CM; MATRIX MOIST 5YR 4/4, MATRIX MOIST 5YR 4/6; SILT LOAM; WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, VERY FINE AND FINE AND MEDIUM ROOTS; FEW, MICRO PORES; 20% GRAVELLY AND ANGULAR GRAVELLY AND SLATY COARSE FRAGMENTS; BROKEN, CLEAR HORIZON BOUNDARY.

BMU: 6 TO 16 CM, RANGE 6 TO 15 CM; MATRIX MOIST 5YR 4/8, MATRIX MOIST 7.5YR 5/6; SILT LOAM; WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE ROOTS; FEW, MICRO PORES; 20% GRAVELLY AND ANGULAR GRAVELLY AND SLATY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BC: 16 TO 27 CM, RANGE 9 TO 12 CM; MATRIX MOIST 10YR 5.5/6; GRAVELLY SILT LOAM; WEAK TO MODERATE, MEDIUM TO COARSE, SUBANGULAR BLOCKY STRUCTURE; FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE ROOTS; MANY, MICRO AND VERY FINE PORES; COMMON, THIN CLAY FILMS IN VOIDS AND/OR CHANNELS ONLY, 10YR 6/6; 40% GRAVELLY AND ANGULAR GRAVELLY AND SLATY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY; MEDIUM ACID 5.6-6.0 FIELD PH.

BCK: 27 TO 44 CM, RANGE 13 TO 19 CM; MATRIX MOIST 10YR 5/6, MATRIX MOIST 10YR 5/4; GRAVELLY SILT LOAM; WEAK TO MODERATE, MEDIUM TO COARSE, SUBANGULAR BLOCKY STRUCTURE; FRIABLE CONSISTENCE; FEW, MICRO ROOTS; COMMON, MICRO AND VERY FINE PORES; VERY WEAK EFFERVESCENCE; MODERATELY CALCAREOUS; 50% GRAVELLY AND ANGULAR GRAVELLY AND SLATY AND COBBLY AND ANGULAR COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

CK1: 44 TO 74 CM, RANGE 29 TO 34 CM; MATRIX MOIST 10YR 5/6; GRAVELLY LOAM; WEAK, MEDIUM TO COARSE, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; VERY FEW, MICRO ROOTS; COMMON, MICRO AND VERY FINE PORES; COMMON, THIN CLAY FILMS IN VOIDS AND/OR CHANNELS ONLY; STRONG EFFERVESCENCE; VERY STRONGLY CALCAREOUS; 60% GRAVELLY AND ANGULAR GRAVELLY AND SLATY AND COBBLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

CK2: 74 TO 91 CM; MATRIX MOIST 10YR 5/4; VERY GRAVELLY COARSE SANDY LOAM; STRUCTURELESS, SINGLE GRAIN STRUCTURE; LOOSE CONSISTENCE; STRONG EFFERVESCENCE; VERY STRONGLY CALCAREOUS; 70% GRAVELLY AND SLATY AND COBBLY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LFH	3.4	42.1							
AE	3.3	1.9		20.4		1.9	0.9	0.1	0.2
BFU	4.2	3.6		30.4		0.8	0.1	-.1	0.2
BMU	5.0	1.5		16.0		0.5	0.0	-.1	0.2
BC	5.7			7.4		4.2	0.9	-.1	0.1
BCK	6.8		8.1						
CK1	7.0		31.2						
CK2	7.1		38.5						

HORIZON	EXTRACT IRON (%) 1	EXTRACT IRON (%) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2	EXTR MN (%)
LFH					
AE					
BFU	0.4		0.6		-.1
BMU	0.1		0.3		-.1
BC					
BCK					
CK1					
CK2					

PHYSICAL DATA (SURVEY)

	% PASSING				PARTICLE SIZE ANALYSIS						% OF SAMPLE				
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
LFH															
AE					1	2	2	3	4	12		81	7		
BFU					4	5	3	4	5	21		67	12		
BMU					2	6	5	5	6	24		69	7		
BC					3	7	5	5	4	24		65	11		
BCK					3	6	5	5	5	24		66	10		
CK1	99	80	48	34	8	10	9	8	7	42		50	8		2.1
CK2	99	71	45	27	11	22	16	10	5	64		34	2		

	MOISTURE STATUS (%)					ENGINEERING							
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LFH													
AE													
BFU													
BMU													
BC													
BCK													
CK1		25.0	2.9			31	31						03
CK2		13.1	1.8			26	21						03

Table D2. Pedon (Alberta 1982 No. 951) describing an Orthic Eutric Brunisol of the AT1 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC EUTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: AT1.

LOCATION: MILITARY GRID REF. 11 UNG 6900 3240; NTS MAP AREA 82K 16*.

CLIMATE: 1200 METERS ABOVE MEAN SEA LEVEL. STATION AT KOOTENAY CROSSI HAS GOOD RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 2 DEG(C) AT 50 CM IN MAY.

VEGETATION: VPN=SD2001*VTN=C38*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY), UNDIFFERENTIATED, EOLIAN, SEDIMENTARY; PARENT MATERIAL 2: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY CALCAREOUS (>40% CACO3), GLACIOFLUVIAL, SEDIMENTARY; LANDFORM CLASSIFICATION: GLACIO FLUVIAL, ERODED(CHANNELLED), TERRACED; SLOPE: 1% SIMPLE SLOPE OF CLASS 2 (0.5-2%), FACING SOUTH, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; SLIGHTLY STONY; NONROCKY.

SPECIAL NOTES: SSN=WT2001*APN=BC5490-214*DATE=82/05/29*TEXTURES OF THIS PEDON ARE FINER THAN NORMAL FOR FG MATERIALS BECAUSE OF THE INFLUENCE OF ARGILLACEOUS STRATA IN THE AREA*

LF: 5 TO 0 CM, RANGE 2 TO 7 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/8, MATRIX MOIST 2.5YR 3/6; ABUNDANT, FINE AND MEDIUM AND COARSE, RANDOM ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

BM: 0 TO 12 CM, RANGE 8 TO 16 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/6; SILT LOAM; VERY WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE, RANDOM ROOTS; SLIGHTLY POROUS, FEW PORES; 10% GRAVELLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2BCK: 12 TO 19 CM, RANGE 6 TO 8 CM; HORIZON MOIST; MATRIX MOIST 10YR 6/3; GRAVELLY SILT LOAM; WEAK TO MODERATE, FINE, SUBANGULAR BLOCKY STRUCTURE; FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM, RANDOM ROOTS; SLIGHTLY POROUS, FEW PORES; WEAK EFFERVESCENCE; WEAKLY CALCAREOUS; 30% GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2CK1: 19 TO 50 CM, RANGE 29 TO 34 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/3; VERY GRAVELLY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE, RANDOM ROOTS; STRONG EFFERVESCENCE; VERY STRONGLY CALCAREOUS; 60% GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

2CK2: 50 TO 70 CM; HORIZON MOIST; MATRIX MOIST 10YR 6/2; VERY GRAVELLY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; WEAKLY CEMENTEDBY LIME; FEW, MICRO AND VERY FINE AND FINE, RANDOM ROOTS; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 60% GRAVELLY AND COBBLY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	3.9	46.5							
BM	6.0	2.1		29.1		13.8	1.1	-.1	0.2
2BCK	6.5		4.7						
2CK1	6.7		27.4						
2CK2	7.1		49.3						

HORIZON	EXTRACT IRON (%) 1	EXTRACT IRON (%) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2	EXTR MN (%)
LF					
BM	0.1		0.1		-.1
2BCK					
2CK1					
2CK2					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LF														
BM										32		60	8	
2BCK										34		56	10	
2CK1										42		50	8	
2CK2	99	65	32	26						47		45	8	

PHYSICAL DATA

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ENGINEERING ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
BM													
2BCK													
2CK1													
2CK2		21.9	7.3			34	36						03

Table D3. Pedon (Alberta 1982 No. 967) describing an Orthic Humo-Ferric Podzol of the BP2 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC HUMO-FERRIC PODZOL. SOIL MAP UNIT: NOTATION: BP2.

LOCATION: MILITARY GRID REF. 11 UNG 4580 7460; NTS MAP AREA 82N 1*.

CLIMATE: 2160 METERS ABOVE MEAN SEA LEVEL. STATION AT MARBLE CANYON HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 2 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VPN=SD2137*VTN=C23*DATE=82/09/23*.

SOIL SITE: PARENT MATERIAL 1: MODERATE CHEMICAL WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY), UNDIFFERENTIATED, FLUVIOEOLIAN, UNDIFFERENTIATED OR UNDETERMINED; PARENT MATERIAL 2: FRACTURED WEATHERING, FRAGMENTAL (STONES,COBBLES AND GRAVEL), EXTREMELY CALCAREOUS (>40% CACO3), COLLUVIAL, LIMESTONE; LANDFORM CLASSIFICATION: INACTIVE COLLUVIAL, HUMMOCKY; SLOPE: 25% COMPLEX SLOPE OF CLASS 6 (16-30%), FACING WEST, SITE AT MIDDLE POSITION, STRONGLY MOUNDED MICROTOPOGRAPHY,20 M LONG; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; EXCEEDINGLY STONY; NONROCKY; PRESENT LAND USE: OUTDOOR RECREATION.

SPECIAL NOTES: SSN=BM2146*APN=BC5391-072*LFH=CAN,A LANDSLIDE DEPOSIT*PM1:SILTY-LOAMY PROB OF EOLIAN ORIG BUT SUBSEQUENTLY REWORKED, HENCE FE=GRADES TO COARSER COLL MAT DOWN*SOME UPPER SOLUM DISTURBANCE,THUS TURBIC PHASE*2CK2 IS FRAGMENTAL*

LFH: 3 TO 0 CM, RANGE 2 TO 7 CM; MATRIX MOIST 10YR 2/2; PLENTIFUL, FINE AND MEDIUM AND COARSE AND MICRO AND VERY FINE ROOTS; WAVY, ABRUPT HORIZON BOUNDARY.

BHFU: 0 TO 9 CM, RANGE 0 TO 14 CM; MATRIX MOIST 10YR 4/4; SILT LOAM; VERY WEAK, MEDIUM TO COARSE, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, FINE AND MEDIUM AND MICRO AND VERY FINE ROOTS; COMMON, MICRO AND VERY FINE PORES; BROKEN, ABRUPT HORIZON BOUNDARY.

B+AU: 9 TO 18 CM, RANGE 0 TO 11 CM; MATRIX MOIST 10YR 4/3, MATRIX MOIST 10YR 5/3; SILT LOAM; VERY WEAK, MEDIUM TO COARSE, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, FINE AND MICRO AND VERY FINE ROOTS; COMMON, MICRO AND VERY FINE PORES; BROKEN, ABRUPT HORIZON BOUNDARY.

BF: 18 TO 30 CM, RANGE 8 TO 21 CM; MATRIX MOIST 7.5YR 4/4; SILT LOAM; VERY WEAK, MEDIUM TO COARSE, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, FINE AND MEDIUM AND MICRO AND VERY FINE ROOTS; COMMON, MICRO PORES; 10% ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

2BCK: 30 TO 55 CM, RANGE 17 TO 43 CM; MATRIX MOIST 10YR 4/4; SILT LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; STRUCTURELESS SECONDARY STRUCTURE; LOOSE CONSISTENCE; VERY FEW, MICRO AND VERY FINE ROOTS; WEAK EFFERVESCENCE; STRONGLY CALCAREOUS; 60% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

2CK1: 55 TO 70 CM, RANGE 0 TO 20 CM; MATRIX MOIST 10YR 5/4; SILT LOAM; STRUCTURELESS STRUCTURE; LOOSE CONSISTENCE; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 70% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; BROKEN, CLEAR HORIZON BOUNDARY.

2CK2: 70 CM; STRUCTURELESS STRUCTURE; LOOSE CONSISTENCE; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 80% ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LFH	4.4	38.2							
BHFU	5.1	6.7		36.3		10.5	0.4	0.0	0.2
B+AU	5.4	6.0		31.0		17.0	0.7	0.0	0.1
BF	5.7	3.2		28.6		14.2	0.3	0.0	-.1
2BCK	6.6		24.7						
2CK1	6.8		60.9						
2CK2									

HORIZON	EXTRACT IRON (%) 1	EXTRACT IRON (%) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2	EXTR MN (%)
LFH					
BHFU	0.6		0.8		-.1
B+AU	0.8		0.5		-.1
BF	0.3		0.5		-.1
2BCK					
2CK1					
2CK2					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	% OF SAMPLE TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LFH														
BHFU										29		63	8	
B+AU										30		63	7	
BF										37		56	7	
2BCK										39		57	4	
2CK1	99	81	48	29						45		52	3	
2CK2														

PHYSICAL DATA

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ENGINEERING ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LFH													
BHFU													
B+AU													
BF													
2BCK													
2CK1		10.3	5.6			44	36						03
2CK2													

Table D4. Pedon (Alberta 1982 No. 983) describing an Orthic Eutric Brunisol of the BS2 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC EUTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: BS2.

LOCATION: MILITARY GRID REF. 11 UNG 7100 1660; NTS MAP AREA 82J 12*.

CLIMATE: 2410 METERS ABOVE MEAN SEA LEVEL. STATION AT SINCLAIR PASS HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 5 DEG(C) AT 20 CM IN SEPTEMBER, NO. 2 WAS 5 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VPN=MF2140*VTN=H17*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND FINE LOAMY AND FINE SILTY (18 TO 35% CLAY), WEAKLY CALCAREOUS (1 TO 6% CACO3), COLLUVIAL, SEDIMENTARY; LANDFORM CLASSIFICATION: COLLUVIAL, SOLIFLUCTED, BLANKET; SLOPE: 67% SIMPLE SLOPE OF CLASS 8 (46-70%), FACING SOUTHWEST, SITE AT UPPER SLOPE POSITION; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, RAPID SURFACE RUNOFF, SEEPAGE ABSENT; MODERATELY STONY; NONROCKY.

SPECIAL NOTES: SSN=DA2135*APN=BC5490-230*DATE=82/09/27*LFM=CB/RI-5*TURBIC PHASE*PH=6.616) AT 20CM*EOLIAN + SLOPE WASH MATERIAL MIXED WITH COLLUVIUM IN UPPER SOLUM*

LF: 3 TO 0 CM, RANGE 2 TO 4 CM; HORIZON MOIST; MATRIX MOIST ; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

AHU: 0 TO 3 CM, RANGE 2 TO 9 CM; HORIZON MOIST; MATRIX MOIST 5YR 3.5/2, MATRIX MOIST 5YR 5/2; SILT LOAM; WEAK, FINE, GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; WAVY, ABRUPT HORIZON BOUNDARY.

BMU: 3 TO 11 CM, RANGE 4 TO 12 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 4/4; SILT LOAM; WEAK, FINE TO MEDIUM, GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; WAVY, ABRUPT HORIZON BOUNDARY.

AHB: 11 TO 18 CM, RANGE 0 TO 11 CM; HORIZON MOIST; MATRIX MOIST 5YR 2.5/2; SILT LOAM; WEAK, FINE TO MEDIUM, GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; BROKEN, ABRUPT HORIZON BOUNDARY.

BMB: 18 TO 25 CM, RANGE 5 TO 12 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/6, MATRIX MOIST 7.5YR 4/6; SILT LOAM; WEAK, FINE, SUBANGULAR BLOCKY STRUCTURE; WEAK TO MODERATE, MEDIUM, GRANULAR SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE ROOTS; 30% ANGULAR GRAVELLY AND ANGULAR COBBLY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BC: 25 TO 53 CM, RANGE 21 TO 33 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/5; GRAVELLY SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; WEAK TO MODERATE, MEDIUM, GRANULAR SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; VERY FEW, MICRO AND VERY FINE ROOTS; 70% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

CK: 53 TO 105 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 6/6; GRAVELLY CLAY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; MODERATE EFFERVESCENCE; WEAKLY CALCAREOUS; 80% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	5.2	25.3							
AHU	4.8	9.5		39.7		14.0	1.0	-.1	0.4
BMU	4.9	3.3		25.0		9.2	0.6	-.1	0.2
AHB	4.7	7.0		35.6		9.9	0.6	-.1	0.2
BMB	5.7			19.7		10.5	0.2	-.1	0.1
BC	6.4			19.1		16.3	0.2	0.1	0.1
CK	6.8		4.6						

HORIZON	EXTRACT IRON (%) 1	EXTRACT IRON (%) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2	EXTR MN (%)
LF					
AHU					
BMU	0.3		0.3		-.1
AHB					
BMB	0.2		0.3		-.1
BC					
CK					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LF														
AHU										16		60	24	
BMU										22		55	20	
AHB										17		58	25	
BMB										22		61	17	
BC										26		55	19	
CK	99	83	64	59						29		42	29	

PHYSICAL DATA

ENGINEERING

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AHU													
BMU													
AHB													
BMB													
BC													
CK		29.3	12.5			24	42						GM

Table D5. Pedon (Alberta 1982 No. 973) describing an Eluviated Eutric Brunisol of the BY6 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ELUVIATED EUTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: BY6.

LOCATION: MILITARY GRID REF. 11 UNB 6300 1740; NTS MAP AREA 82K 16*.

CLIMATE: 1740 METERS ABOVE MEAN SEA LEVEL. STATION AT KOOTENAY CROSSI HAS MODERATE RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 2 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VPH=PA2045=VTH=C14*.

SOIL SITE: PARENT MATERIAL 1: UNSPECIFIED WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY), UNDIFFERENTIATED, EOLIAN, UNDIFFERENTIATED OR UNDETERMINED; PARENT MATERIAL 2: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY) AND STRATIFIED (MINERAL), EXTREMELY CALCAREOUS (>40% CACO3), MORAINAL (TILL), LIMESTONE AND QUARTZITE; LANDFORM CLASSIFICATION: MORAINAL, BLANKET; SLOPE: 32% COMPLEX SLOPE OF CLASS 7 (31-45%), FACING NORTHEAST, SITE AT UPPER SLOPE POSITION, SEVERELY MOUNDED MICROTOPOGRAPHY,100 M LONG; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; SLIGHTLY STONY; NONROCKY; PRESENT LAND USE: OUTDOOR RECREATION.

SPECIAL NOTES: SSN=BM2156*APN=BCS390-034*LFM=EV/MB/MH=EOLIAN & TILL MIXED IN UPPER SOLUM*TILL SLIGHTLY COARSER + MORE STRATIFIED THAN TYPICAL FOR BY6*SOME BF DEVELOPMENT IN BM*DATE=82/09/26*

LF: 5 TO 0 CM, RANGE 4 TO 6 CM; MATRIX MOIST 10YR 2/2; PLENTIFUL, MICRO AND VERY FINE ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

AE: 0 TO 4 CM, RANGE 2 TO 7 CM; MATRIX DRY 10YR 6/1, MATRIX DRY 10YR 6/2; SILT LOAM; STRUCTURELESS STRUCTURE; LOOSE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; WAVY, ABRUPT HORIZON BOUNDARY.

BM: 4 TO 14 CM, RANGE 4 TO 23 CM; MATRIX MOIST 5YR 5/6, MATRIX MOIST 5YR 3/4; SILT LOAM; WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; MANY, MICRO AND VERY FINE PORES; 10% GRAVELLY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

2BC: 14 TO 22 CM, RANGE 0 TO 12 CM; MATRIX MOIST 10YR 3/4, MATRIX DRY 10YR 5/6; GRAVELLY SILT LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE ROOTS; 30% GRAVELLY AND ANGULAR GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; BROKEN, CLEAR HORIZON BOUNDARY.

2BCK: 22 TO 40 CM, RANGE 10 TO 32 CM; MATRIX DRY 10YR 3/3; GRAVELLY LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; VERY FEW, MICRO AND VERY FINE ROOTS; WEAK EFFERVESCENCE; EXTREMELY CALCAREOUS; 50% GRAVELLY AND ANGULAR GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2CK1: 40 TO 57 CM, RANGE 6 TO 17 CM; MATRIX MOIST 10YR 5/2; GRAVELLY SANDY LOAM; STRUCTURELESS STRUCTURE; VERY WEAK, FINE, SUBANGULAR BLOCKY SECONDARY STRUCTURE; FRIABLE CONSISTENCE; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 50% GRAVELLY AND ANGULAR GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2CK2: 57 TO 90 CM, RANGE 30 TO 37 CM; MATRIX MOIST 10YR 4/2; GRAVELLY SANDY LOAM; STRUCTURELESS STRUCTURE; VERY WEAK, FINE, SUBANGULAR BLOCKY SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 50% GRAVELLY AND ANGULAR GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

2CK3: 90 TO 105 CM; MATRIX MOIST 10YR 5/2; GRAVELLY SANDY LOAM; STRUCTURELESS STRUCTURE; WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY SECONDARY STRUCTURE; FRIABLE CONSISTENCE; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 50% GRAVELLY AND ANGULAR GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%	C.E.C. (ME/100G) BUFF.	PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	4.5	42.1							
AE	3.8	5.8		25.1		5.4	2.5	0.1	0.3
BM	4.8	3.3		23.9		3.7	1.6	-.1	0.1
2BC	6.1			16.8		12.4	5.4	-.1	0.1
2BCK	6.6		47.6						
2CK1	6.8		53.0						
2CK2	6.9		52.1						
2CK3	7.1		67.6						

HORIZON	EXTRACT IRON (%) 1	2	EXTRACT ALUMINUM (%) 1	2	EXTR MN (%)
LF					
AE					
BM	0.3		0.6		-.1
2BC					
2BCK					
2CK1					
2CK2					
2CK3					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
LF															
AE					0	1	3	5	6	15		75	10		
BM					1	2	3	6	4	18		66	16		0.7
2BC					0	1	4	10	11	26		53	21		
2BCK					5	10	11	15	11	52		38	10		
2CK1					9	14	13	16	10	62		33	5		
2CK2	99	76	52	41	7	12	17	21	10	67		27	6		2.1
2CK3	99	83	59	42	9	15	13	17	10	64		30	6		

PHYSICAL DATA

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ENGINEERING ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AE													
BM													
2BC													
2BCK													
2CK1													
2CK2		11.0	3.2			22	21						03
2CK3		9.9	3.0			17	16						03

Table D6. Pedon (Alberta 1982 No. 960) describing an Eluviated Dystric Brunisol of the CA2 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ELUVIATED DYSTRIC BRUNISOL. SOIL MAP UNIT: OTHER, NOTATION: CA2.

LOCATION: MILITARY GRID REF. 11 UNG 6100 6520; NTS MAP AREA 82N 1*.

CLIMATE: 1570 METERS ABOVE MEAN SEA LEVEL. STATION AT MARBLE CANYON HAS MODERATE RELEVANCE TO THE SOIL SITE.

VEGETATION: VPN=HD2137*VTN=C25*.

SOIL SITE: PARENT MATERIAL 1: MODERATE CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), GLACIOFLUVIAL AND MORAINAL (TILL), MIXED; LANDFORM CLASSIFICATION: GLACIO FLUVIAL AND MORAINAL, BLANKET; SLOPE: 55% SIMPLE SLOPE OF CLASS 8 (46-70%), FACING WEST, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, SEEPAGE ABSENT.

SPECIAL NOTES: SSN=WT2192*APN=BC5391=069*DATE=82/09/26* *TURBIC PHASE PEDON*C1 HZN HAS POCKETS OF VARIOUS TEXTURE FROM GRSIL TO VGLS *TEXTURES MORE VARIABLE THAN MODAL FOR CA2*

LF: 4 TO 0 CM, RANGE 3 TO 6 CM; HORIZON MOIST; MATRIX MOIST ; PLENTIFUL, MICRO AND VERY FINE AND FINE ROOTS; WAVY, CLEAR HORIZON BOUNDARY.

AEU: 0 TO 3 CM, RANGE 0 TO 4 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/2; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE ROOTS; 40% ANGULAR GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS; BROKEN, CLEAR HORIZON BOUNDARY.

BMU: 3 TO 15 CM, RANGE 10 TO 30 CM; HORIZON MOIST; MATRIX MOIST 5YR 5/6, MATRIX MOIST 7.5YR 5/7; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MEDIUM AND COARSE ROOTS; 40% ANGULAR GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS; BROKEN, GRADUAL HORIZON BOUNDARY.

BM: 15 TO 28 CM, RANGE 0 TO 16 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 6/6; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, FINE ROOTS; 50% ANGULAR GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY; STRONGLY ACID 5.1-5.5 FIELD PH.

BC: 28 TO 47 CM, RANGE 5 TO 22 CM; HORIZON MOIST; MATRIX MOIST 10YR 6/4; GRAVELLY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; FEW, FINE ROOTS; 60% GRAVELLY AND ANGULAR GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS; IRREGULAR, GRADUAL HORIZON BOUNDARY.

C1: 47 TO 82 CM, RANGE 25 TO 55 CM; HORIZON MOIST; MATRIX MOIST 10YR 6/3; GRAVELLY COARSE SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; STRUCTURELESS, SINGLE GRAIN SECONDARY STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, VERY FINE AND FINE ROOTS; 70% GRAVELLY AND ANGULAR GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS; IRREGULAR, GRADUAL HORIZON BOUNDARY.

C2: 82 TO 103 CM; HORIZON MOIST; MATRIX MOIST 10YR 6/3; GRAVELLY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, VERY FINE ROOTS; 50% GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	5.3	27.0						
AEU	4.4	6.1	29.4		6.3	1.5	0.1	0.2
BMU	5.0	2.0	17.1		2.5	0.6	0.2	0.2
BM	5.3	0.5	6.0		0.0	0.2	-.1	0.1
BC	5.1		3.4		0.4	0.1	0.0	0.1
C1	5.3		3.1		0.4	0.1	0.0	0.1
C2	5.4		4.1		1.0	0.2	0.1	-.1

HORIZON	EXTRACT IRON %) .	EXTRACT IRON %) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2	EXTR MN (%)
LF					
AEU					
BMU	0.2		0.2		-.1
BM	0.1		0.1		-.1
BC					
C1					
C2					

PHYSICAL DATA (SURVEY)

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	PARTICLE SIZE ANALYSIS V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
LF															
AEU					8	14	8	7	6	43		50	7		
BMU					6	12	8	8	7	41		50	9		
BM					6	14	9	8	6	43		50	7		
BC					7	16	12	10	7	52		41	7		
C1					14	22	14	9	5	64		30	6		
C2	99	94	73	52	4	9	8	11	11	43		49	8		1.6

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	ENGINEERING OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AEU													
BMU													
BM													
BC													
C1													
C2		22.0	4.5			26	25						97

Table D7. Pedon (Alberta 1982 No. 981) illustrating gleyed Podzolic soils of the CV1 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC HUMIC PODZOL. SOIL MAP UNIT: NOTATION: CV1.

LOCATION: MILITARY GRID REF. 11 UNG 7240 5900; NTS MAP AREA 82O 4W.

CLIMATE: 1910 METERS ABOVE MEAN SEA LEVEL. STATION AT MARBLE CANYON HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 8 DEG(C) AT 20 CM IN SEPTEMBER, NO. 2 WAS 6 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VPN=MF2142*VTN=O14*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, STRATIFIED (MINERAL AND ORGANIC), UNDIFFERENTIATED, FLUVIAL AND ORGANIC; PARENT MATERIAL 2: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), MODERATELY TO VERY STRONGLY CALCAREOUS (6-40% CACO3), MORAINAL (TILL), SEDIMENTARY; LANDFORM CLASSIFICATION: MORAINAL, BLANKET; SLOPE: 20% SIMPLE SLOPE OF CLASS 6 (16-30%), FACING SOUTH, SITE AT LOWER SLOPE POSITION; SOIL MOISTURE AND DRAINAGE: POORLY DRAINED, MODERATELY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE PRESENT, 0.6 M TO WATERTABLE; SLIGHTLY STONY; NONROCKY.

SPECIAL NOTES: SSN=DA2133*APN=BC5391-057*DATE=82/09/24*LFM=FV/MB/RI*PEATY PHASE*

OF: 13 TO 10 CM, RANGE 2 TO 4 CM; HORIZON MOIST; MATRIX MOIST ; ORGANIC; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

OH: 10 TO 0 CM, RANGE 5 TO 15 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/1; ORGANIC; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; WAVY, ABRUPT HORIZON BOUNDARY.

BHF: 0 TO 1 CM, RANGE 0 TO 4 CM; HORIZON MOIST; MATRIX MOIST 5YR 4/4; SILT LOAM; WEAK, FINE, GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; BROKEN, ABRUPT HORIZON BOUNDARY.

BH: 1 TO 21 CM, RANGE 13 TO 25 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 3/2; SILT LOAM; WEAK, FINE, GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; WEAKLY CALCAREOUS; WAVY, ABRUPT HORIZON BOUNDARY.

2BG: 21 TO 33 CM, RANGE 10 TO 15 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4; SILT LOAM; WEAK, FINE, SUBANGULAR BLOCKY STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, MICRO AND VERY FINE ROOTS; MODERATELY CALCAREOUS; 50% GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, DIFFUSE HORIZON BOUNDARY.

2BCKGJ: 33 TO 54 CM, RANGE 10 TO 25 CM; HORIZON MOIST; MATRIX MOIST 10YR 4.5/4; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, MICRO ROOTS; MODERATE EFFERVESCENCE; MODERATELY CALCAREOUS; 50% GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, DIFFUSE HORIZON BOUNDARY.

2CKGJ: 54 TO 75 CM; HORIZON WET; MATRIX MOIST ; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; NONSTICKY CONSISTENCE; STRONG EFFERVESCENCE; VERY STRONGLY CALCAREOUS; 50% GRAVELLY AND COBBLY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
OF									
OH	6.4	21.0							
BHF									
BH	6.6	8.2	1.0	58.4		42.5	5.0	0.0	0.0
2BG	6.7	1.2	10.5						
2BCKGJ	7.0		18.1						
2CKGJ	7.1		30.3						

HORIZON	EXTRACT IRON (%) 1	EXTRACT IRON (%) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2	EXTR MN (%)
OF					
OH					
BHF					
BH	0.3		0.5		-.1
2BG	0.1		0.1		-.1
2BCKGJ					
2CKGJ					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
OF														
OH														
BHF														
BH										22		69	9	
2BG										35		58	7	
2BCKGJ										43		53	4	
2CKGJ	99	86	62	46						46		50	4	

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ENGINEERING ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
OF													
OH													
BHF													
BH													
2BG													
2BCKGJ													
2CKGJ		21.8	2.3			27	24						03

Table D8. Pedon (Alberta 1982 No. 964) describing an Orthic Eutric Brunisol of the DG1 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC EUTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: DG1.

LOCATION: MILITARY GRID REF. 11 UNG 7490 1400; NTS MAP AREA 82J 12*.

CLIMATE: 1610 METERS ABOVE MEAN SEA LEVEL. STATION AT SINCLAIR PASS HAS GOOD RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 5 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VPN=SD2134*VTN=C01*..

SOIL SITE: PARENT MATERIAL 1: SHATTERED AND WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY CALCAREOUS (>40% CACO3), COLLUVIAL, LIMESTONE; DEPTH TO BEDROCK IS 0.9 M; LANDFORM CLASSIFICATION: COLLUVIAL, VENEER; SLOPE: 62% SIMPLE SLOPE OF CLASS 8 (46-70%), FACING SOUTH, SITE AT MIDDLE POSITION, LEVEL MICROTOPOGRAPHY,500 M LONG; SOIL MOISTURE AND DRAINAGE: RAPIDLY DRAINED, MODERATELY PERVIOUS, RAPID SURFACE RUNOFF, SEEPAGE ABSENT; MODERATELY STONY; SLIGHTLY ROCKY; PRESENT LAND USE: OUTDOOR RECREATION.

SPECIAL NOTES: SSN=BW2143*APN=BC5490-238*LFM=CV/RI*LITHIC PHASE*IRREGULAR BEDROCK SURFACE*DATE=82/09/21*A FEW SUBROUNDED COARSE FRAGMENTS IN PROFILE*

LF: 3 TO 0 CM, RANGE 2 TO 4 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/2; SMOOTH, ABRUPT HORIZON BOUNDARY.

AB: 0 TO 2 CM, RANGE 1 TO 3 CM; HORIZON MOIST; MATRIX MOIST 10YR 4/2; GRAVELLY SILT LOAM; VERY WEAK, COARSE, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; VERY WEAK EFFERVESCENCE; MODERATELY CALCAREOUS; 40% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

BMK: 2 TO 10 CM, RANGE 7 TO 11 CM; HORIZON DRY; MATRIX DRY 10YR 4/4; GRAVELLY SILT LOAM; VERY WEAK, MEDIUM TO COARSE, SUBANGULAR BLOCKY STRUCTURE; STRUCTURELESS SECONDARY STRUCTURE; SOFT CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; STRONG EFFERVESCENCE; MODERATELY CALCAREOUS; 50% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

BCK: 10 TO 17 CM, RANGE 0 TO 9 CM; HORIZON DRY; MATRIX DRY 10YR 6/4; GRAVELLY SILT LOAM; VERY WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; STRUCTURELESS SECONDARY STRUCTURE; SOFT CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; STRONG EFFERVESCENCE; STRONGLY CALCAREOUS; 50% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; BROKEN, ABRUPT HORIZON BOUNDARY.

BMBK1: 17 TO 22 CM, RANGE 0 TO 12 CM; HORIZON DRY; MATRIX DRY 10YR 3/3; GRAVELLY SILT LOAM; WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; SOFT CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND COARSE ROOTS; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 50% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; BROKEN, ABRUPT HORIZON BOUNDARY.

BMBK2: 22 TO 35 CM, RANGE 15 TO 30 CM; HORIZON DRY; MATRIX DRY 10YR 4/4; GRAVELLY SILT LOAM; VERY WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; STRUCTURELESS SECONDARY STRUCTURE; SOFT CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND COARSE ROOTS; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 50% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

CK: 35 TO 85 CM, RANGE 33 TO 57 CM; HORIZON DRY; MATRIX DRY 10YR 5/3.5, MATRIX DRY 10YR 4/4; GRAVELLY SILT LOAM; VERY WEAK, COARSE, SUBANGULAR BLOCKY STRUCTURE; STRUCTURELESS SECONDARY STRUCTURE; SOFT CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE ROOTS; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 60% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; IRREGULAR, ABRUPT HORIZON BOUNDARY.

R: 85 CM

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%
LF	5.4	30.7	
AB	6.8	6.4	11.2
BMK	7.2	4.8	9.2
BCK	7.5	5.1	24.3
BMBK1	7.4	7.1	52.4
BMBK2	7.4	5.2	56.2
CK	7.5		71.1
R			

HORIZON	EXTRACT IRON (%) 1	2	EXTRACT ALUMINUM (%) 1	2	EXTR MN (%)
LF					
AB					
BMK	0.1		-.1		-.1
BCK					
BMBK1	0.1		0.1		-.1
BMBK2	0.1		0.2		-.1
CK					
R					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
LF															
AB										23		64	13		
BMK										22		59	19		
BCK										26		62	12		
BMBK1										23		65	12		
BMBK2										25		64	11		
CK	99	70	45	32						34		58	8		1.3
R															

ENGINEERING

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AB													
BMK													
BCK													
BMBK1													
BMBK2													
CK		23.0	12.2			41	49						83
R													

Table D9. Pedon (Alberta 1982 No. 952) describing an Orthic Regosol of the DG3 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC REGOSOL. SOIL MAP UNIT: NOTATION: DG3.

LOCATION: MILITARY GRID REF. 11 UNG 7100 1070; NTS MAP AREA 82J 12*.

CLIMATE: 1370 METERS ABOVE MEAN SEA LEVEL. STATION AT RADIUM HAS MODERATE RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 5 DEG(C) AT 50 CM IN MAY.

VEGETATION: VPN=MF2136*VTN=C01*DATE=82/05/31*..

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND FINE LOAMY AND FINE SILTY (18 TO 35% CLAY), MODERATELY TO VERY STRONGLY CALCAREOUS (6-40% CACO3), COLLUVIAL, SEDIMENTARY; DEPTH TO BEDROCK IS 0.6 M; LANDFORM CLASSIFICATION: COLLUVIAL, VENEER; SLOPE: 70% SIMPLE SLOPE OF CLASS 9 (71-100%), FACING SOUTHWEST, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: RAPIDLY DRAINED, RAPIDLY PERVIOUS, VERY RAPID SURFACE RUNOFF, SEEPAGE ABSENT; VERY STONY; VERY ROCKY.

SPECIAL NOTES: SSN=WT2002*APN=BC5490-230* LFM=CV/RI+RI*LITHIC PHASE PEDON* DEPTH TO BEDROCK VARIES FROM 27 TO 95 CM WITHIN PEDON*AHK RESISTS WETTING*ROOT MATS AT BEDROCK

L: 1 TO 0 CM, RANGE 0 TO 3 CM; WEAK EFFERVESCENCE; 30% ANGULAR GRAVELLY AND ANGULAR COBBLY COARSE FRAGMENTS; BROKEN, ABRUPT HORIZON BOUNDARY.

AHK: 0 TO 3 CM, RANGE 2 TO 5 CM; MATRIX DRY 10YR 5/2, MATRIX MOIST 10YR 3/1.5; SILT LOAM; WEAK, FINE TO MEDIUM, GRANULAR STRUCTURE; SOFT CONSISTENCE; FEW, VERY FINE AND FINE, RANDOM ROOTS; MODERATELY POROUS; MODERATE EFFERVESCENCE; MODERATELY CALCAREOUS; 40% ANGULAR GRAVELLY AND ANGULAR COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

CK1: 3 TO 20 CM, RANGE 22 TO 30 CM; MATRIX DRY 10YR 7/3, MATRIX MOIST 10YR 5/4; GRAVELLY SILT LOAM; WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; SOFT CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE, RANDOM ROOTS; MODERATELY POROUS; STRONG EFFERVESCENCE; MODERATELY CALCAREOUS; 60% ANGULAR GRAVELLY AND ANGULAR COBBLY COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

CK2: 20 TO 60 CM, RANGE 0 TO 65 CM; MATRIX DRY 10YR 6/3, MATRIX MOIST 7.5YR 4/3; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; LOOSE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE, RANDOM ROOTS; HIGHLY POROUS; STRONG EFFERVESCENCE; STRONGLY CALCAREOUS; 30% ANGULAR GRAVELLY AND ANGULAR COBBLY COARSE FRAGMENTS; IRREGULAR, ABRUPT HORIZON BOUNDARY.

R: 60 CM

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%
L	6.5	33.8	
AHK	7.0	11.4	6.9
CK1	7.2	5.2	14.1
CK2	7.4	0.9	19.7
R			

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	% OF SAMPLE TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
L														
AHK										17		60	23	
CK1										20		58	22	
CK2	99	67	49	40						23		60	17	
R														

ENGINEERING

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
L													
AHK													
CK1													
CK2		49.0	26.9			73	76						03
R													

Table D10. Pedon (Alberta 1981 No. 34) describing an Orthic Gray Luvisol of the DR2 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC GRAY LUVISOL. SOIL MAP UNIT: NOTATION: DR2.

LOCATION: MILITARY GRID REF. 11 UNG 6880 3850; NTS MAP AREA 82K 16E.

CLIMATE: 1330 METERS ABOVE MEAN SEA LEVEL. STATION AT KOOTENAY CROSSI HAS GOOD RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 4 DEG(C) AT 50 CM IN OCTOBER.

VEGETATION: VFN=HD1133*VTN=C38*DATE=81/10/06*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, FINE LOAMY AND FINE SILTY (18 TO 35% CLAY), EXTREMELY CALCAREOUS (>40% CACO3), MORAINAL (TILL), MIXED; PARENT MATERIAL 2: SHATTERED WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY), MODERATELY TO VERY STRONGLY CALCAREOUS (6-40% CACO3), RESIDUAL, SHALE; LANDFORM CLASSIFICATION: MORAINAL, VENEER; SLOPE: 17% COMPLEX SLOPE OF CLASS 6 (16-30%), FACING WEST, SITE AT MIDDLE POSITION, SLIGHTLY MOUNDED MICROTOPOGRAPHY,100 M LONG; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, SLOWLY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; SLIGHTLY STONY; NONROCKY.

SPECIAL NOTES: SSN=BH1105*APN=BC5490-214*LFM=MV/RUV/RR*2CKFRAG IS A SUBSAMPLE OF 2CK AND IS CRUSHED RESIDUAL FRAGMENTS TOO SOFT TO BE CONSIDERED COARSE FRAGMENTS*RU SURFACE IRREGULAR*

LF: 3 TO 0 CM, RANGE 2 TO 4 CM; 10YR 2/1; SMOOTH, ABRUPT HORIZON BOUNDARY.

AB: 0 TO 12 CM, RANGE 10 TO 14 CM; MATRIX DRY 7.5YR 5/4; SILT LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; FRIABLE CONSISTENCE; PLENTIFUL, VERY FINE AND FINE AND MEDIUM ROOTS; FEW, MICRO PORES; 30% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BT: 12 TO 17 CM, RANGE 5 TO 7 CM; EXPED MOIST 10YR 4/6, CRUSHED MOIST 10YR 5/6; SILTY CLAY LOAM; MODERATE, MEDIUM TO COARSE, SUBANGULAR BLOCKY STRUCTURE; FRIABLE CONSISTENCE; PLENTIFUL, VERY FINE AND FINE AND MEDIUM ROOTS; MANY, MICRO PORES; COMMON, VERY THIN CLAY FILMS IN MANY VOIDS/CHANNELS AND ON SOME VERTICAL AND HORIZONTAL PED FACES; WEAKLY CALCAREOUS; 30% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BCK: 17 TO 25 CM, RANGE 7 TO 10 CM; MATRIX DRY 10YR 5/4; SILT LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; SLIGHTLY HARD CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; MODERATE EFFERVESCENCE; VERY STRONGLY CALCAREOUS; 30% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

CK1: 25 TO 42 CM, RANGE 15 TO 18 CM; MATRIX DRY 10YR 5/3; SILT LOAM; STRUCTURELESS STRUCTURE; VERY WEAK, MEDIUM, SUBANGULAR BLOCKY SECONDARY STRUCTURE; SLIGHTLY HARD CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE ROOTS; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 30% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

CK2: 42 TO 100 CM, RANGE 18 TO 72 CM; MATRIX DRY 2.5Y 6/2; SILT LOAM; STRUCTURELESS STRUCTURE; WEAK TO MODERATE, FINE, ANGULAR BLOCKY SECONDARY STRUCTURE PSEUDO; HARD CONSISTENCE; FEW, VERY FINE AND FINE AND MEDIUM ROOTS; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 30% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; IRREGULAR, ABRUPT HORIZON BOUNDARY.

2CK: 100 TO 115 CM; MATRIX DRY 5Y 7/1; SILT LOAM; STRUCTURELESS STRUCTURE; MODERATE TO STRONG, MEDIUM TO COARSE, PLATY SECONDARY STRUCTURE BEDDED; HARD CONSISTENCE; VERY FEW, FINE AND MEDIUM ROOTS; STRONG EFFERVESCENCE; STRONGLY CALCAREOUS.

2CKFRAG: 100 TO 115 CM; SILT.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%	C.E.C. (ME/100G) BUFF.	PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	4.7	41.0							
AB	5.3	1.8		12.1		7.6	0.7	0.2	0.2
BT	6.7	1.5	2.2	19.1		20.2	2.7	-.1	0.4
BCK	7.3		29.0						
CK1	7.5		51.2						
CK2	7.7		47.0						
2CK	7.7		23.4						
2CKFRAG	7.8								

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	% OF SAMPLE V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
LF															
AB										15		71	14		
BT										17		52	31		
BCK										31		56	13		
CK1										19		57	24		
CK2	99	87	76	69						26		55	19		1.7
2CK	99	99	99	99						7		80	13		1.3
2CKFRAG										2		87	11		

ENGINEERING

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AB													
BT													
BCK													
CK1													
CK2		22.8	6.8			22	26						19
2CK		40.6	4.2			36	40						09
2CKFRAG													

Table D11. Pedon (Alberta 1982 No. 979) describing an Orthic Humo-Ferric Podzol of the EG3 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC HUMO-FERRIC PODZOL. SOIL MAP UNIT: NOTATION: EG3.

LOCATION: MILITARY GRID REF. 11 UNG 6050 5640; NTS MAP AREA 82N 1*.

CLIMATE: 2100 METERS ABOVE MEAN SEA LEVEL. STATION AT MARBLE CANYON HAS GOOD RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 4 DEG(C) AT 20 CM IN SEPTEMBER, NO. 2 HAS 3 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VPN=MF2140*VTN=C23*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), MEDIUM ACID TO NEUTRAL (PH 5.6-7.3), MORAINAL (TILL), SLATE; LANDFORM CLASSIFICATION: MORAINAL, VENEER; SLOPE: 17% COMPLEX SLOPE OF CLASS 6 (16-30%), FACING SOUTH, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; SLIGHTLY STONY; NONROCKY.

SPECIAL NOTES: SSN=DA2131*APN=BC5391-055*DATE=82/09/23*LFM=MV/RR*PH=5.2-5.4(4)*ALSO TOOK GRAB SAMPLE OF BHF FROM A POCKET ON ANOTHER FACE OF PIT*

LF: 3 TO 0 CM, RANGE 2 TO 5 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/1; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

AE: 0 TO 6 CM, RANGE 3 TO 13 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/1; SILT LOAM; WEAK, FINE, PLATY STRUCTURE; FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 40% SLATY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BF: 6 TO 28 CM, RANGE 13 TO 30 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 4/4, MATRIX MOIST 7.5YR 5/6; LOAM; WEAK TO MODERATE, FINE TO MEDIUM, GRANULAR STRUCTURE; FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; 50% SLATY AND FLAGGY COARSE FRAGMENTS; IRREGULAR, DIFFUSE HORIZON BOUNDARY.

BC1: 28 TO 55 CM, RANGE 22 TO 30 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4; SILT LOAM; WEAK TO MODERATE, MEDIUM, GRANULAR STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, MICRO AND VERY FINE AND FINE ROOTS; 60% SLATY AND FLAGGY COARSE FRAGMENTS; WAVY, DIFFUSE HORIZON BOUNDARY.

BC2: 55 TO 85 CM; HORIZON MOIST; MATRIX MOIST 10YR 4/3; COARSE SANDY LOAM; STRUCTURELESS, SINGLE GRAIN STRUCTURE; LOOSE CONSISTENCE; VERY FEW, MICRO AND VERY FINE ROOTS; 80% GRAVELLY AND SLATY AND FLAGGY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	3.8	38.0						
AE	3.7	3.7	19.0		0.5	0.2	0.1	0.1
BF	4.0	2.4	19.6		0.1	0.0	-.1	0.0
BC1	4.7		9.9		0.2	0.0	-.1	0.0
BC2	4.9		5.2		0.1	0.0	0.0	0.0

HORIZON	EXTRACT IRON (%) 1	EXTRACT IRON (%) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2	EXTR MN (%)
LF					
AE					
BF	0.9		0.3		-.1
BC1					
BC2					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LF														
AE					3	6	3	2	3	17		68	15	
BF					9	17	10	6	3	45		45	10	
BC1					7	15	8	6	4	40		52	8	
BC2	99	91	49	19	17	24	8	3	3	55		39	6	

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ENGINEERING ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AE													
BF													
BC1													
BC2		20.5	4.5			43	39						03

Table D12. Pedon (Alberta 1979 No. 95) describing an Orthic Humo-Ferric Podzol of the EF1 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC HUMO-FERRIC PODZOL. SOIL MAP UNIT: NOTATION: EF1.

LOCATION: MILITARY GRID REF. 11 UNG 5460 8690; NTS MAP AREA 82N 8E.

CLIMATE: 2410 METERS ABOVE MEAN SEA LEVEL. STATION AT LAKE LOUISE HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 4 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VPN=PA7188*VTN=LS*.

SOIL SITE: PARENT MATERIAL 1: MODERATE CHEMICAL WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), MORAINAL (TILL), SEDIMENTARY AND SANDSTONE; LANDFORM CLASSIFICATION: UNCONSOLIDATED AND MORAINAL AND UNDIFFERENTIATED, HUMMOCKY; SLOPE: 20% COMPLEX SLOPE OF CLASS 6 (16-30%), FACING EAST, SITE AT UPPER SLOPE POSITION, MODERATELY MOUNDED MICROTOPOGRAPHY,50 M LONG; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, RAPID SURFACE RUNOFF, SEEPAGE ABSENT; EXCEEDINGLY STONY.

SPECIAL NOTES: SSN=GC60%6*AFN=443-054*RLU=15*PCF=3GR,1CB(2-3)3GR,2CB,2ST(4-6)*BC+C HORIZONS VERY FIRM IN PLACE (DENSE + COMPACT), DIFFICULT TO DIG*TILL IS CIRQUE END MORAINE WITH BOLDERS STREWN OVERSURFACE*REPRESENTATIVE SITE + PROFILE*LFM=MB/RH*

AH: 0 TO 3 CM, RANGE 2 TO 5 CM; MATRIX MOIST 10YR 3/2; SILT LOAM; STRUCTURELESS STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, VERY FINE AND FINE ROOTS; WAVY, ABRUPT HORIZON BOUNDARY.

AE: 3 TO 13 CM, RANGE 7 TO 11 CM; MATRIX MOIST 7.5YR 6/2; SANDY LOAM; VERY WEAK, COARSE, PLATY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, VERY FINE ROOTS; FEW, FINE PORES; GRAVELLY AND COBBLY COARSE FRAGMENTS; IRREGULAR, ABRUPT HORIZON BOUNDARY.

BF: 13 TO 28 CM, RANGE 5 TO 24 CM; MATRIX MOIST 5YR 4/3, MATRIX MOIST 5YR 3/3; SILT LOAM; WEAK, MEDIUM TO COARSE, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, VERY FINE ROOTS; COMMON, VERY FINE PORES; GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BC: 28 TO 48 CM, RANGE 5 TO 24 CM; MATRIX MOIST 7.5YR 6/6; SANDY LOAM; WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, VERY FINE ROOTS; COMMON, VERY FINE AND FINE PORES; GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

C1: 48 TO 95 CM, RANGE 45 TO 55 CM; MATRIX MOIST 2.5Y 6/4; SANDY LOAM; STRUCTURELESS STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, VERY FINE, OBLIQUE ROOTS; COMMON, VERY FINE AND FINE, RANDOM PORES; FEW, MODERATELY THICK CLAY FILMS IN VOIDS AND/OR CHANNELS ONLY; GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

C2: 95 TO 105 CM; MATRIX MOIST 2.5Y 6/4; SANDY LOAM; STRUCTURELESS STRUCTURE; VERY FRIABLE CONSISTENCE; GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
AH	5.2	27.5	61.0		21.0	4.7	0.1	3.0
AE	4.2	2.0	8.8		1.3	0.4	-.1	0.1
BF	4.4	4.6	23.2		1.3	0.4	-.1	0.1
BC	4.5		3.5		0.5	0.1	0.0	-.1
C1	4.7		2.6		2.3	0.2	0.0	-.1
C2	4.3		1.8		0.6	0.2	0.0	-.1

HORIZON	EXTRACT IRON (%) 1	EXTRACT IRON (%) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2
AH				
AE				
BF	0.5		0.5	
BC	0.2		-.1	
C1				
C2				

PHYSICAL DATA (SURVEY)

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	PARTICLE SIZE ANALYSIS % OF SAMPLE V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
AH										23		56	21	7
AE					8	11	14	14	7	54		36	10	1
BF					3	6	8	10	11	38		53	9	0
BC					5	12	18	19	9	63		30	7	0
C1					8	10	13	16	8	55		36	9	2
C2					6	12	16	16	8	58		34	8	2

Table D13. Pedon (Alberta 1978 No. 59) describing an Eluviated Dystric Brunisol of the EN3 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ELUVIATED DYSTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: EN3.

LOCATION: MILITARY GRID REF. 11 UNM 2520 4060; NTS MAP AREA 82N 15E.

CLIMATE: 2030 METERS ABOVE MEAN SEA LEVEL. SOIL TEMP READING NO. 1 WAS 2 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VPN=PA8157*VTN=04..

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH 5.5), COLLUVIAL, SEDIMENTARY; LANDFORM CLASSIFICATION: COLLUVIAL, BOULDERY, AVALANCHED, BLANKET; SLOPE: 65% SIMPLE SLOPE OF CLASS 8 (46-70%), FACING EAST, SITE AT MIDDLE POSITION, MODERATELY MOUNDED MICROTOPOGRAPHY,600 M LONG; SOIL MOISTURE AND DRAINAGE: RAPIDLY DRAINED, RAPIDLY PERVIOUS, VERY RAPID SURFACE RUNOFF, SEEPAGE ABSENT; EXCESSIVELY STONY.

SPECIAL NOTES: SSN=GC8041*APN=015-049*PCF=4CB,1GR(2)SCB,2GR(3-4)*THE BM2 WAS SAMPLED FROM 100-125CM*LFM=CB/PI-A*

H: 1 TO 0 CM, RANGE 1 TO 3 CM; MATRIX MOIST 10YR 3/2; WAVY, ABRUPT HORIZON BOUNDARY.

AE: 0 TO 7 CM, RANGE 5 TO 16 CM; MATRIX MOIST 10YR 6/2; SILT LOAM; WEAK, COARSE, PLATY STRUCTURE; STRUCTURELESS, MASSIVE SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, FINE AND MEDIUM ROOTS; MANY, VERY FINE PORES; 50% GRAVELLY AND COBBLY COARSE FRAGMENTS; IRREGULAR, CLEAR HORIZON BOUNDARY.

BM1: 7 TO 40 CM, RANGE 39 TO 40 CM; MATRIX MOIST 10YR 5/6, MATRIX MOIST 5YR 4/6; LOAMY COARSE SAND; STRUCTURELESS, SINGLE GRAIN STRUCTURE; WEAK, FINE, SUBANGULAR BLOCKY SECONDARY STRUCTURE; LOOSE CONSISTENCE; ABUNDANT, VERY FINE ROOTS; 60% GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, DIFFUSE HORIZON BOUNDARY.

BM2: 40 TO 125 CM; MATRIX MOIST 10YR 5/8; LOAMY COARSE SAND; STRUCTURELESS, SINGLE GRAIN STRUCTURE; WEAK, FINE, SUBANGULAR BLOCKY SECONDARY STRUCTURE; LOOSE CONSISTENCE; FEW, MICRO AND MEDIUM ROOTS; 60% GRAVELLY AND COBBLY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
H	3.7	27.7						
AE	4.5	1.8	19.7		3.9	1.0	0.1	0.1
BM1	5.4	0.7	6.7		1.3	0.4	0.1	0.1
BM2	4.6	0.6	7.9		0.5	0.2	-.1	0.1

HORIZON	EXTRACT IRON (%) 1	EXTRACT IRON (%) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2
H				
AE				
BM1	0.1		0.1	
BM2	0.2		0.1	

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	% OF SAMPLE V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
H														
AE					3	7	8	8	6	32		57	1	
BM1					15	21	17	18	7	78		22	0	
BM2	99	74	46	38	15	10	15	16	2	66		34	0	

ENGINEERING

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
H													
AE		28.5	3.5										
BM1													
BM2		11.0	2.5									11	03

Table D14. Pedon (Alberta 1981 No. 36) describing an Orthic Eutric Brunisol of the FR1 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC EUTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: FR1.

LOCATION: MILITARY GRID REF. 11 UNB 6510 3030; NTS MAP AREA 82K 16E.

CLIMATE: 1200 METERS ABOVE MEAN SEA LEVEL. STATION AT KOOTENAY CROSSI HAS VERY GOOD RELEVANCE TO THE SOIL SITE.

VEGETATION: VPN=PA1077*VTN=C19*.

SOIL SITE: PARENT MATERIAL 1: COARSE LOAMY AND COARSE SILTY (<18% CLAY), MODERATELY TO VERY STRONGLY CALCAREOUS (6-40% CACO3), FLUVIAL, MIXED AND SEDIMENTARY AND METAMORPHIC; LANDFORM CLASSIFICATION: FLUVIAL, ERODED(CHANNELLED), FAN; SLOPE: 3% SIMPLE SLOPE OF CLASS 3 (2-5%), FACING SOUTHWEST, SITE AT MIDDLE POSITION, MODERATELY MOUNDED MICROTOPOGRAPHY,; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, SEEPAGE ABSENT; NONSTONY; NONROCKY.

SPECIAL NOTES: SSN=DA1096*APN=BC5490-214*DATE=81/10/06*POSSIBLE EOLIAN INFLUENCE AT SURFACE*

LF: 3 TO 0 CM, RANGE 2 TO 5 CM; MATRIX MOIST ; PLENTIFUL, VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

BM: 0 TO 17 CM; RANGE 12 TO 20 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/8; SILT LOAM; WEAK TO MODERATE, FINE TO MEDIUM, PLATY STRUCTURE; WEAK, FINE, GRANULAR SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; VERY FEW, VERY FINE PORES; 10% GRAVELLY AND COBBLY COARSE FRAGMENTS; IRREGULAR, ABRUPT HORIZON BOUNDARY.

BC: 17 TO 27 CM, RANGE 7 TO 15 CM; HORIZON MOIST; MATRIX MOIST 10YR 6/4; GRAVELLY SILT LOAM; WEAK TO MODERATE, FINE TO MEDIUM AND MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, VERY FINE AND FINE ROOTS; VERY WEAK EFFERVESCENCE; 40% GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

CK1: 27 TO 59 CM, RANGE 26 TO 36 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 6/2; VERY GRAVELLY SILT LOAM; STRUCTURELESS, SINGLE GRAIN STRUCTURE; LOOSE CONSISTENCE; STRONGLY CEMENTEDBY LIME, CONTINUOUS; VERY FEW AND FEW, VERY FINE AND FINE ROOTS; STRONG EFFERVESCENCE; VERY STRONGLY CALCAREOUS; 60% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

CK2: 59 TO 83 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 6/2; VERY GRAVELLY COARSE SANDY LOAM; STRUCTURELESS, SINGLE GRAIN STRUCTURE; LOOSE CONSISTENCE; STRONGLY CEMENTEDBY LIME, CONTINUOUS; VERY FINE AND FINE ROOTS; STRONG EFFERVESCENCE; VERY STRONGLY CALCAREOUS; 60% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%	C.E.C. (ME/100G) BUFF.	PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	4.4	40.9							
BM	5.3	1.4		15.6		3.4	-.1	-.1	0.1
BC	6.4		0.5						
CK1	7.3		25.5						
CK2	7.4		39.3						

HORIZON	EXTRACT IRON (%) 1	2	EXTRACT ALUMINUM (%) 1	2
LF				
BM	0.1		0.2	
BC				
CK1				
CK2				

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 75-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LF														
BM										27		67	6	
BC										24		62	14	
CK1	99	69	43	31	6	13	9	6	4	38		56	6	
CK2	99	88	56	38	10	20	16	7	3	56		40	4	

ENGINEERING

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
BM													
BC													
CK1						33	37						17
CK2		14.4	2.4			29	26						03

Table D15. Pedon (Alberta 1982 No. 955) describing an Orthic Humo-Ferric Podzol of the FV5 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC HUMO-FERRIC PODZOL. SOIL MAP UNIT: NOTATION: FV5.

LOCATION: MILITARY GRID REF. 11 UNG 6010 6430; NTS MAP AREA 82H 1*.

CLIMATE: 1590 METERS ABOVE MEAN SEA LEVEL. STATION AT MARBLE CANYON HAS MODERATE RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 5 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VPN=HD2132*VTN=S13*..

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), WEAKLY CALCAREOUS (1 TO 6% CACO3), COLLUVIAL, METAMORPHIC AND SLATE; LANDFORM CLASSIFICATION: COLLUVIAL, AVALANCHED, BLANKET; SLOPE: 65% SIMPLE SLOPE OF CLASS 8 (46-70%), FACING NORTHEAST, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, RAPIDLY PERVIOUS, RAPID SURFACE RUNOFF, SEEPAGE ABSENT; VERY STONY; NONROCKY.

SPECIAL NOTES: SSN=MT2187*APN=BC5391-055*DATE=82/09/22*LFM=CB/RI-A* PH=6.1 AT 25 CM*OCCASIONAL CARBONATE PENDANTS UNDER COARSE FRAGMENTS IN C1*

L: 28 TO 24 CM, RANGE 5 TO 3 CM; HORIZON MOIST; MATRIX MOIST ; WAVY, CLEAR HORIZON BOUNDARY.

F: 24 TO 5 CM, RANGE 20 TO 18 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 2.5/2; PLENTIFUL, FINE AND MEDIUM, RANDOM ROOTS; 20% CHANNERY AND ANGULAR COBBLY AND FLAGGY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

FH: 5 TO 0 CM, RANGE 3 TO 5 CM; HORIZON MOIST; MATRIX MOIST N 2; FEW, FINE, RANDOM ROOTS; 20% CHANNERY AND ANGULAR COBBLY AND FLAGGY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BM: 0 TO 13 CM, RANGE 12 TO 16 CM; HORIZON MOIST; MATRIX MOIST 10YR 3/3; GRAVELLY SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, MEDIUM, RANDOM ROOTS; MODERATELY POROUS; 60% CHANNERY AND ANGULAR COBBLY AND FLAGGY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BF: 13 TO 27 CM, RANGE 13 TO 17 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 3/3; GRAVELLY SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, MEDIUM, RANDOM ROOTS; MODERATELY POROUS; 60% CHANNERY AND ANGULAR COBBLY AND FLAGGY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY; SLIGHTLY ACID 6.1-6.5 FIELD PH.

BC: 27 TO 42 CM, RANGE 23 TO 28 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4; GRAVELLY SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, FINE, RANDOM ROOTS; MODERATELY POROUS; 60% CHANNERY AND ANGULAR COBBLY AND FLAGGY COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

C1: 42 TO 78 CM, RANGE 30 TO 38 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 6/3; GRAVELLY SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, FINE, RANDOM ROOTS; MODERATELY POROUS; 70% CHANNERY AND ANGULAR COBBLY AND FLAGGY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

C2: 78 TO 91 CM, RANGE 9 TO 13 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 6/3; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; MODERATELY POROUS; WEAKLY CALCAREOUS; 60% CHANNERY AND ANGULAR COBBLY AND FLAGGY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

C+FB: 91 TO 115 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 6/3, MATRIX MOIST 10YR 3/2; GRAVELLY SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; FEW, FINE AND MEDIUM, RANDOM ROOTS; MODERATELY POROUS; WEAKLY CALCAREOUS; 80% CHANNERY AND ANGULAR COBBLY AND FLAGGY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
L	5.0	39.0							
F	5.4	19.9							
FH	5.8	18.1							
BM	5.9	3.2		21.4		14.3	0.3	0.0	-.1
BF	5.7	2.8		20.2		12.1	0.3	0.0	-.1
BC	5.8	2.2		16.1		8.5	0.2	0.0	-.1
C1	6.1			9.1		6.3	0.1	0.2	-.1
C2	6.6		0.9	8.5		8.8	0.2	0.2	0.1
C+FB	6.6	2.70	1.1						

HORIZON	EXTRACT IRON (%) 1	EXTRACT IRON (%) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2	EXTR MN (%)
L					
F					
FH					
BM	0.4		0.1		-.1
BF	0.4		0.2		-.1
BC	0.3		0.3		-.1
C1					
C2					
C+FB					

PHYSICAL DATA (SURVEY)

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	PARTICLE SIZE ANALYSIS % OF SAMPLE V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
L															
F															
FH															
BM										33		59	8		
BF										38		54	8		
BC										43		50	7		
C1										38		55	7		
C2	99	91	64	47						32		59	9		1.1
C+FB	99	81	50	31						36		56	8		

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	ENGINEERING SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
L													
F													
FH													
BM													
BF													
BC													
C1													
C2													
C+FB		36.7	8.7			44	51						83

Table D16. Pedon (Alberta 1982 No. 959) describing an Eluviated Dystric Brunisol of the FV6 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ELUVIATED DYSTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: FV6.

LOCATION: MILITARY GRID REF. 11 UNG 5790 6530; NTS MAP AREA 82N 1*.

CLIMATE: 1870 METERS ABOVE MEAN SEA LEVEL. STATION AT MARBLE CANYON HAS MODERATE RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 5 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VPN=HD2136*VTN=C14*.

SOIL SITE: PARENT MATERIAL 1: MODERATE CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), MEDIUM ACID TO NEUTRAL (PH 5.6-7.3), COLLUVIAL, SLATE; PARENT MATERIAL 2: WEAK CHEMICAL WEATHERING, FRAGMENTAL (STONES,COBBLES AND GRAVEL) AND SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), MEDIUM ACID TO NEUTRAL (PH 5.6-7.3), RESIDUAL, SLATE; DEPTH TO BEDROCK IS 1.1 M; LANDFORM CLASSIFICATION: COLLUVIAL, VENEER; SLOPE: 75% SIMPLE SLOPE OF CLASS 9 (71-100%), FACING EAST, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, RAPID SURFACE RUNOFF, SEEPAGE ABSENT; SLIGHTLY STONY; MODERATELY ROCKY.

SPECIAL NOTES: SSN=WT2191*APN=BC5391-070*DATE=82/09/24*LFH=CV/RUV/RI*PH=4.8 AT 30 CM*

LFH: 3 TO 0 CM, RANGE 2 TO 5 CM; HORIZON DRY; MATRIX MOIST 5YR 3/2; PLENTIFUL, MICRO AND VERY FINE AND MEDIUM, HORIZONTAL ROOTS; WAVY, ABRUPT HORIZON BOUNDARY.

AE: 0 TO 3 CM, RANGE 1 TO 4 CM; HORIZON DRY; MATRIX MOIST 10YR 6/2; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM, RANDOM ROOTS; 60% CHANNERY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BM1: 3 TO 15 CM, RANGE 9 TO 14 CM; HORIZON DRY; MATRIX MOIST 7.5YR 5/5; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; FEW, VERY FINE AND FINE AND MEDIUM AND COARSE, RANDOM ROOTS; 60% CHANNERY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BM2: 15 TO 27 CM, RANGE 9 TO 13 CM; HORIZON DRY; MATRIX MOIST 7.5YR 5/7; LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, FINE, RANDOM ROOTS; 60% CHANNERY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY; VERY STRONGLY ACID 4.6-5.0 FIELD PH.

BC: 27 TO 46 CM, RANGE 11 TO 20 CM; HORIZON DRY; MATRIX MOIST 10YR 6/5; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; VERY FEW, FINE, RANDOM ROOTS; 70% CHANNERY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2BC1: 46 TO 83 CM, RANGE 30 TO 50 CM; HORIZON DRY; MATRIX MOIST 2.5Y 6/4; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, FINE, RANDOM ROOTS; 80% CHANNERY AND FLAGGY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2BC2: 83 TO 105 CM, RANGE 10 TO 25 CM; HORIZON DRY; MATRIX MOIST 2.5Y 6/4; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; 80% CHANNERY AND FLAGGY COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

R: 105 CM

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LFH	3.9	35.4						
AE	3.9	7.0	24.1		0.9	0.6	0.0	0.2
BM1	4.4	2.0	12.9		1.1	0.2	0.0	0.1
BM2	4.4	1.2	10.0		0.4	0.2	0.0	-.1
BC	4.5		4.0		0.2	0.1	0.0	-.1
2BC1	5.0		3.6		0.4	0.2	0.0	-.1
2BC2	6.0		2.9		2.3	0.1	0.0	-.1
R								

HORIZON	EXTRACT IRON (%) 1	EXTRACT IRON (%) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2	EXTR MN (%)
LFH					
AE					
BM1	0.2		0.1		-.1
BM2	0.2		0.2		0.0
BC					
2BC1					
2BC2					
R					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	% OF SAMPLE V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LFH														
AE										40		54	6	
BM1										40		52	8	
BM2										47		46	7	
BC	99	95	72	51						43		50	7	
2BC1										37		58	5	
2BC2	99	47	19	10						43		51	6	
R														

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	ENGINEERING SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LFH													
AE													
BM1													
BM2													
BC		22.1	3.7			27	27						07
2BC1													
2BC2		26.4	4.0			30							01
R													

Table D17. Pedon (Alberta 1982 No. 982) describing a Rego Gleysol of the HC1 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: REGO GLEYSOL. SOIL MAP UNIT: NOTATION: HC1.

LOCATION: MILITARY GRID REF. 11 UNG 5940 6900; NTS MAP AREA 82N 1*.

CLIMATE: 1440 METERS ABOVE MEAN SEA LEVEL. STATION AT MARBLE CANYON HAS GOOD RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 9 DEG(C) AT 20 CM IN SEPTEMBER, NO. 2 WAS 8 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VPN=MF2147*VTN=011*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, STRATIFIED (MINERAL AND ORGANIC), UNDIFFERENTIATED, ORGANIC; PARENT MATERIAL 2: WEAK CHEMICAL WEATHERING, STRATIFIED (MINERAL), EXTREMELY CALCAREOUS (>40% CACO3), FLUVIAL, SEDIMENTARY; LANDFORM CLASSIFICATION: FLUVIAL, LEVEL; SLOPE: 1% SIMPLE SLOPE OF CLASS 2 (0.5-2%), FACING WEST, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: POORLY DRAINED AND VERY POORLY DRAINED, SLOWLY PERVIOUS, SLOW SURFACE RUNOFF, SEEPAGE PRESENT, 0.4 M TO APPARENT WATERTABLE; NONSTONY; NONROCKY.

SPECIAL NOTES: SSN=DA2134*APN=BC5391-070*DATE=82/09/26*PEATY PHASE*

OF1: 19 TO 11 CM, RANGE 6 TO 11 CM; HORIZON MOIST; MATRIX MOIST 5YR 3/2; ORGANIC; ABUNDANT, VERY FINE AND FINE AND MEDIUM AND MICRO ROOTS; WAVY, CLEAR HORIZON BOUNDARY.

OH1: 11 TO 3 CM, RANGE 6 TO 12 CM; HORIZON MOIST; MATRIX MOIST 5YR 2.5/1; ORGANIC; ABUNDANT, VERY FINE AND FINE AND MEDIUM AND MICRO ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

OF2: 3 TO 1 CM, RANGE 1 TO 5 CM; HORIZON MOIST; MATRIX MOIST 2.5YR 3/6; ORGANIC; ABUNDANT, VERY FINE AND FINE AND MEDIUM AND MICRO ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

OH2: 1 TO 0 CM, RANGE 1 TO 3 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/1; ORGANIC; ABUNDANT, VERY FINE AND FINE AND MEDIUM AND MICRO ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

CKG1: 0 TO 14 CM, RANGE 11 TO 23 CM; HORIZON MOIST; MATRIX MOIST 5Y 6/3; SILT LOAM; MANY, MEDIUM, PROMINENT, 7.5YR 5/8 MOTTLES; 2.5YR 4/8 MOTTLES; STRUCTURELESS, MASSIVE STRUCTURE; NONSTICKY, FIRM CONSISTENCE; PLENTIFUL, VERY FINE AND FINE AND MICRO ROOTS; MODERATE EFFERVESCENCE; STRONGLY CALCAREOUS; WAVY, ABRUPT HORIZON BOUNDARY.

CKG2: 14 TO 55 CM; HORIZON MOIST; MATRIX MOIST N 5/0; VERY GRAVELLY LOAMY COARSE SAND; FEW, MEDIUM, PROMINENT, 5YR 5/6 MOTTLES; 2.5YR 4/8 MOTTLES; STRUCTURELESS, SINGLE GRAIN STRUCTURE; NONSTICKY, LOOSE CONSISTENCE; FEW, VERY FINE AND FINE AND MICRO ROOTS; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 60% GRAVELLY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%
OF1	6.3	38.4	
OH1	6.6	36.4	
OF2	6.4	40.2	
OH2			
CKG1	6.8	1.0	16.0
CKG2	7.0	0.5	46.3

PHYSICAL DATA (SURVEY)

	PARTICLE SIZE ANALYSIS													
	% PASSING										% OF SAMPLE			
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
OF1														
OH1														
OF2														
OH2														
CKG1					0	0	0	2	12	14		77	9	
CKG2	99	91	77	62	4	23	33	13	4	77		20	3	

	MOISTURE STATUS (%)								ENGINEERING				
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
OF1													
OH1													
OF2													
OH2													
CKG1													
CKG2		6.0	2.1				21						07

Table D18. Pedon (Alberta 1982 No. 954) describing a Cumulic Regosol of the HD3 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978. SUBGROUP: CUMULIC REGOSOL. SOIL MAP UNIT: NOTATION: HD3.

LOCATION: MILITARY GRID REF. 11 UNG 7210 2620; NTS MAP AREA 82J 13*.

CLIMATE: 1170 METERS ABOVE MEAN SEA LEVEL. STATION AT KOOTENAY CROSSI HAS GOOD RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 HAS 7 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VPN=HD2131*VTN=C37?*..

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY) AND STRATIFIED (MINERAL), MODERATELY TO VERY STRONGLY CALCAREOUS (6-40% CACO3) AND EXTREMELY CALCAREOUS (>40% CACO3), FLUVIAL, SEDIMENTARY AND METAMORPHIC; LANDFORM CLASSIFICATION: FLUVIAL, ERODED(CHANNELLED), FAN; SLOPE: 9% SIMPLE SLOPE OF CLASS 4 (6-9%), FACING NORTHEAST, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, RAPIDLY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; MODERATELY STONY; NONROCKY.

SPECIAL NOTES: SSN=MT2186*APN=BC5490-217*DATE=82/09/21*

LF: 16 TO 0 CM, RANGE 13 TO 17 CM; HORIZON MOIST; MATRIX MOIST 5YR 3/1, MATRIX MOIST 5YR 5/9; FEW, MEDIUM, RANDOM ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

BMK: 0 TO 2 CM, RANGE 1 TO 4 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4; SILT LOAM; STRUCTURELESS STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM, RANDOM ROOTS; HIGHLY POROUS, MANY, MEDIUM AND COARSE, RANDOM, CONTINUOUS, SIMPLE, INTERSTITIAL PORES; WEAK EFFERVESCENCE; WEAKLY CALCAREOUS; 30% GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

CK1: 2 TO 8 CM, RANGE 5 TO 7 CM; HORIZON MOIST; MATRIX MOIST 10YR 3/2; VERY GRAVELLY COARSE SANDY LOAM; STRUCTURELESS, SINGLE GRAIN STRUCTURE; LOOSE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM, RANDOM ROOTS; HIGHLY POROUS, MANY, MEDIUM AND COARSE, RANDOM, CONTINUOUS, SIMPLE, INTERSTITIAL PORES; STRONG EFFERVESCENCE; VERY STRONGLY CALCAREOUS; 70% GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

CK2: 8 TO 22 CM, RANGE 13 TO 18 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/2; VERY GRAVELLY COARSE SANDY LOAM; STRUCTURELESS, SINGLE GRAIN STRUCTURE; LOOSE CONSISTENCE; FEW, FINE, RANDOM ROOTS; HIGHLY POROUS, MANY, MEDIUM AND COARSE, RANDOM, CONTINUOUS, SIMPLE, INTERSTITIAL PORES; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 80% GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

CK3: 22 TO 25 CM, RANGE 2 TO 4 CM; HORIZON MOIST; MATRIX MOIST 10YR 4/2; LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM, RANDOM ROOTS; HIGHLY POROUS, MANY, MEDIUM AND COARSE, RANDOM, CONTINUOUS, SIMPLE, INTERSTITIAL PORES; STRONG EFFERVESCENCE; VERY STRONGLY CALCAREOUS; 30% GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

CK4: 25 TO 46 CM, RANGE 16 TO 24 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/2; VERY GRAVELLY COARSE SANDY LOAM; STRUCTURELESS, SINGLE GRAIN STRUCTURE; LOOSE CONSISTENCE; VERY FEW, FINE, RANDOM ROOTS; HIGHLY POROUS, MANY, MEDIUM AND COARSE, RANDOM, CONTINUOUS, SIMPLE, INTERSTITIAL PORES; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 80% GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

CK5: 46 TO 49 CM, RANGE 2 TO 5 CM; HORIZON MOIST; MATRIX MOIST 10YR 4/2; LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE AND MEDIUM, RANDOM ROOTS; HIGHLY POROUS, MANY, MEDIUM AND COARSE, RANDOM, CONTINUOUS, SIMPLE, INTERSTITIAL PORES; STRONG EFFERVESCENCE; STRONGLY CALCAREOUS; 30% GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

CK6: 49 TO 75 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/2; VERY GRAVELLY COARSE SANDY LOAM; STRUCTURELESS, SINGLE GRAIN STRUCTURE; LOOSE CONSISTENCE; VERY FEW, RANDOM ROOTS; HIGHLY POROUS, MANY, MEDIUM AND COARSE, RANDOM, CONTINUOUS, SIMPLE, INTERSTITIAL PORES; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 80% GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%
LF	3.8	48.90	
BMK	5.6	6.60	2.3
CK1	6.7	4.50	30.1
CK2	6.9	1.50	42.2
CK3	7.0	2.80	29.4
CK4	7.1	1.30	44.4
CK5	7.2	1.00	24.1
CK6	7.3	1.20	49.7

HORIZON	EXTRACT IRON (%) 1	EXTRACT IRON (%) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2	EXTR MN (%)
LF					
BMK	0.4		0.1		-.1
CK1					
CK2					
CK3					
CK4					
CK5					
CK6					

PHYSICAL DATA (SURVEY)

	% PASSING				PARTICLE SIZE ANALYSIS						% OF SAMPLE			
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LF														
BMK					1	1	2	3	9	10		62	20	
CK1					13	20	16	11	6	66		27	7	
CK2					9	24	18	12	5	68		20	4	
CK3					2	5	7	13	16	43		48	9	
CK4					14	24	17	11	5	73		29	7	
CK5	99	92	81	76	2	4	7	16	20	49		43	8	
CK6	99	49	26	12	13	22	17	18	5	67		26	7	

	MOISTURE STATUS (%)								ENGINEERING				
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
BMK													
CK1													
CK2													
CK3													
CK4													
CK5													
CK6		9.5	3.0			20	25						01

Table D19. Pedon (Alberta 1982 No. 37) describing an Orthic Regosol of the HD6 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC REGOSOL. SOIL MAP UNIT: NOTATION: HD6.

LOCATION: MILITARY GRID REF. 11 UNG 7330 5040; NTS MAP AREA 82O 4W.

CLIMATE: 1260 METERS ABOVE MEAN SEA LEVEL. STATION AT KOOTENAY CROSSI HAS POOR RELEVANCE TO THE SOIL SITE.

VEGETATION: VPN=PA1078*VTN=H0.

SOIL SITE: PARENT MATERIAL 1: SKELETAL (>35% OF PARTICLES 2-25 CM) AND SANDY, MODERATELY TO VERY STRONGLY CALCAREOUS (6-40% CACO3), GLACIOFLUVIAL, MIXED AND SEDIMENTARY AND METAMORPHIC; LANDFORM CLASSIFICATION: GLACIO FLUVIAL, ERODED(CHANNELLED), TERRACED; SLOPE: 0.5% SIMPLE SLOPE OF CLASS 2 (0.5-2%), FACING SOUTHEAST, SITE AT MIDDLE POSITION, MODERATELY MOUNDED MICROTOPOGRAPHY,; SOIL MOISTURE AND DRAINAGE: RAPIDLY DRAINED, RAPIDLY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; EXCESSIVELY STONY; NONROCKY.

SPECIAL NOTES: SSN=DA1097*APN=DC5391-004*DATE=81/10/07*DRAINAGE VARIABLE RELATED TO SEASONAL WATER TABLE*

L: 2 TO 0 CM, RANGE 1 TO 3 CM; MATRIX MOIST ; PLENTIFUL, VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

CK1: 0 TO 5 CM, RANGE 4 TO 6 CM; HORIZON MOIST; MATRIX MOIST 10YR 4/2; GRAVELLY FINE SANDY LOAM; WEAK, FINE TO MEDIUM, PLATY STRUCTURE; STRUCTURELESS, SINGLE GRAIN SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; HIGHLY POROUS; STRONG EFFERVESCENCE; VERY STRONGLY CALCAREOUS; 30% GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

CK2: 5 TO 20 CM, RANGE 8 TO 10 CM; HORIZON MOIST; MATRIX MOIST 5Y 4/1; VERY GRAVELLY LOAMY SAND; STRUCTURELESS, SINGLE GRAIN STRUCTURE; LOOSE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; HIGHLY POROUS; STRONG EFFERVESCENCE; VERY STRONGLY CALCAREOUS; 70% GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

CK3: 20 TO 52 CM, RANGE 28 TO 37 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 3/0; VERY GRAVELLY COARSE SAND; STRUCTURELESS, SINGLE GRAIN STRUCTURE; LOOSE CONSISTENCE; FEW, MICRO AND VERY FINE ROOTS; HIGHLY POROUS; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 80% GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

CK4: 52 TO 101 CM; HORIZON MOIST; 2.5Y 3/0; VERY GRAVELLY COARSE SAND; STRUCTURELESS, SINGLE GRAIN STRUCTURE; LOOSE CONSISTENCE; VERY FEW, MICRO ROOTS; HIGHLY POROUS; STRONG EFFERVESCENCE; VERY STRONGLY CALCAREOUS; 80% GRAVELLY AND COBBLY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%
L	6.2	34.0	
CK1	7.2	6.0	35.1
CK2	7.3	5.9	38.6
CK3	7.4	6.0	44.2
CK4	7.5	5.9	37.4

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING										% OF SAMPLE			
	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
L														
CK1					0	1	8	24	17	50		48	2	
CK2					3	11	27	28	8	77		21	2	
CK3	99	95	56	31	24	35	21	7	2	89		9	2	
CK4	99	95	47	28	12	28	26	16	4	86		12	2	

ENGINEERING

HORIZON	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
L								
CK1								
CK2								
CK3	0.0	0.0						05
CK4								01

Table D20. Pedon (Alberta 1982 No. 968) describing an Orthic Humic Regosol of the HE2 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC HUMIC REGOSOL. SOIL MAP UNIT: NOTATION: HE2.

LOCATION: MILITARY GRID REF. 11 UNG 5690 7980; NTS MAP AREA 82N 8E.

CLIMATE: 2420 METERS ABOVE MEAN SEA LEVEL. STATION AT MARBLE CANYON HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 3 DEG(C) AT 15 CM IN SEPTEMBER.

VEGETATION: VPN=SD2138*VTN=L07*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY), MODERATELY TO VERY STRONGLY CALCAREOUS (6-40% CACO3), FLUVIAL AND COLLUVIAL AND EOLIAN, UNDIFFERENTIATED OR UNDETERMINED; DEPTH TO BEDROCK IS 0.1 M; LANDFORM CLASSIFICATION: BEDROCK, SOLIFLUCTED, RIDGED; SLOPE: 32% COMPLEX SLOPE OF CLASS 7 (31-45%), FACING WEST, SITE AT LOWER SLOPE POSITION, SEVERELY MOUNDED MICROTOPOGRAPHY,20 M LONG; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, RAPID SURFACE RUNOFF, SEEPAGE ABSENT; VERY STONY; EXCEEDINGLY ROCKY; PRESENT LAND USE: OUTDOOR RECREATION.

SPECIAL NOTES: SSN=0M2147*APN=BC5391-117*LFM=RR>UV/RR-S*LITHIC PHASE*UV (PM1) CONSISTS OF EOLIAN + COLLUVIAL MATERIALS SUBSEQUENTLY REWORKED BY SLOPE WASH AND SOLIFLUCTION PROCESSES*DATE=82/09/24*

AHK1: 0 TO 3 CM, RANGE 2 TO 5 CM; MATRIX MOIST 10YR 3/1; SILT LOAM; STRUCTURELESS STRUCTURE; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE ROOTS; MODERATE EFFERVESCENCE; VERY STRONGLY CALCAREOUS; WAVY, ABRUPT HORIZON BOUNDARY.

AHK2: 3 TO 12 CM, RANGE 6 TO 14 CM; MATRIX MOIST 10YR 3/1; LOAM; STRUCTURELESS STRUCTURE; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE ROOTS; MODERATE EFFERVESCENCE; VERY STRONGLY CALCAREOUS; 20% ANGULAR GRAVELLY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

R: 12 CM

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%
AHK1	6.9	12.1	25.6
AHK2	7.0	5.6	34.6
R			

PHYSICAL DATA (SURVEY)

	PARTICLE SIZE ANALYSIS													
	% PASSING										% OF SAMPLE			
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
AHK1										32		55	13	
AHK2										42		48	10	
R														

Table D21. Pedon (Alberta 1982 No. 965) describing an Eluviated Dystric Brunisol of the IB4 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ELUVIATED DYSTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: IB4.

LOCATION: MILITARY GRID REF. 11 UNG 5790 6020; NTS MAP AREA 82N 1*.

CLIMATE: 1900 METERS ABOVE MEAN SEA LEVEL. STATION AT MARBLE CANYON HAS GOOD RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 4 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VPN=SD2135*VTN=C14*DATE=82/09/22*.

SOIL SITE: PARENT MATERIAL 1: SHATTERED AND WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND SANDY, MEDIUM ACID TO NEUTRAL (PH 5.6-7.3), COLLUVIAL, SLATE; LANDFORM CLASSIFICATION: INACTIVE COLLUVIAL, HUMMOCKY; SLOPE: 45% COMPLEX SLOPE OF CLASS 7 (31-45%), FACING SOUTHWEST, SITE AT MIDDLE POSITION, SLIGHTLY MOUNDED MICROTOPOGRAPHY,50 M LONG; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; SLIGHTLY STONY; NONROCKY; PRESENT LAND USE: OUTDOOR RECREATION.

SPECIAL NOTES: SSN=BW2144*APN=BC5391-70*LFM=CAN.A LANDSLIDE DEPOSIT*UPPER SOLUM INCLUDING BM ONCE DISTRUDED,PERHAPS BY TREETHROW +/OR SLOPE WASH,BUT DISTURBANCE INSUFFIENT FOR TURBIC PHASE*BORDERLINE TO EUTRIC BRUNISOL*

LF: 2 TO 0 CM, RANGE 1 TO 3 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/2; WAVY, ABRUPT HORIZON BOUNDARY.

AE: 0 TO 4 CM, RANGE 2 TO 6 CM; HORIZON MOIST; MATRIX MOIST 10YR 6/3; GRAVELLY LOAM; VERY WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, VERY FINE AND FINE AND MEDIUM ROOTS; 60% SLATY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BA: 4 TO 13 CM, RANGE 6 TO 12 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4, MATRIX MOIST 7.5YR 5/6; GRAVELLY COARSE SANDY LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, VERY FINE AND FINE AND MEDIUM AND COARSE AND MICRO ROOTS; 50% SLATY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BM: 13 TO 26 CM, RANGE 9 TO 20 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/6; GRAVELLY COARSE SANDY LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; 50% SLATY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BC: 26 TO 75 CM, RANGE 40 TO 60 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/2, MATRIX MOIST 10YR 6/3; VERY GRAVELLY COARSE SANDY LOAM; STRUCTURELESS, SINGLE GRAIN STRUCTURE; LOOSE CONSISTENCE; FEW, MICRO AND VERY FINE ROOTS; 70% SLATY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

C: 75 TO 113 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/2; VERY GRAVELLY LOAMY COARSE SAND; STRUCTURELESS, SINGLE GRAIN STRUCTURE; LOOSE CONSISTENCE; VERY FEW, MICRO AND VERY FINE ROOTS; 70% SLATY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; MEDIUM ACID 5.6-6.0 FIELD PH.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	3.6	31.6						
AE	3.8	3.3	12.0		1.3	0.5	0.0	0.1
BA	4.3	1.6	9.2		0.9	0.1	0.0	0.1
BM	5.1	1.4	10.0		1.0	0.1	0.0	-.1
BC	5.6		3.5		1.3	0.1	0.0	0.0
C	6.1		2.0		1.0	0.1	0.0	-.1

HORIZON	EXTRACT IRON (%) 1	EXTRACT IRON (%) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2	EXTR MN (%)
LF					
AE					
BA					
BM	0.1		0.3		-.1
BC					
C					

PHYSICAL DATA (SURVEY)

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	PARTICLE SIZE ANALYSIS % OF SAMPLE V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LF														
AE					4	11	8	7	6	36		59	5	
BA					13	18	10	8	4	53		41	6	
BM					10	16	10	8	5	49		46	5	
BC					13	28	17	10	4	72		25	3	
C	99	82	49	23	14	35	20	9	2	80		18	2	

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ENGINEERING ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AE													
BA													
BM													
BC													
C		0.2	3.0			29	23						01

Table D22. Pedon (Alberta 1982 No. 978) describing an Orthic Humo-Ferric Podzol of the JN1 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC HUMO-FERRIC PODZOL. SOIL MAP UNIT: NOTATION: JN1.

LOCATION: MILITARY GRID REF. 11 UNG 6090 5720; NTS MAP AREA 82N 1*.

CLIMATE: 2330 METERS ABOVE MEAN SEA LEVEL. STATION AT MARBLE CANYON HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 4 DEG(C) AT 20 CM IN SEPTEMBER, NO. 2 WAS 4 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VPN=MF2139*VTN=L05*..

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY), UNDIFFERENTIATED, EOLIAN; PARENT MATERIAL 2: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), MORAINAL (TILL), SEDIMENTARY AND SLATE; LANDFORM CLASSIFICATION: MORAINAL, CRYOTURBATED, VENEER; SLOPE: 7% COMPLEX SLOPE OF CLASS 4 (6-9%), FACING NORTHWEST, SITE AT UPPER SLOPE POSITION, SEVERELY MOUNDED MICROTOPOGRAPHY,; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, SEEPAGE ABSENT; NONSTONY; NONROCKY.

SPECIAL NOTES: SSN=DA2130*APN=BCS391-055*DATE=82/09/21*LITHIC AND TURBIC PHASE*PCF<5%AGR,SL(2-4)*PH=5.4-5.6(6)*EOLIAN AND TILL PARENT MATERIALS MIXED IN UPPER 16CM*

LF: 2 TO 0 CM, RANGE 1 TO 3 CM; HORIZON MOIST; MATRIX MOIST 10YR 3/1; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

AHEU: 0 TO 4 CM, RANGE 2 TO 7 CM; HORIZON MOIST; MATRIX MOIST 10YR 3/2, MATRIX MOIST 10YR 5/2; SILT LOAM; VERY WEAK, FINE, GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; SLIGHTLY POROUS; WAVY, ABRUPT HORIZON BOUNDARY.

BHFU: 4 TO 9 CM, RANGE 0 TO 12 CM; HORIZON MOIST; MATRIX MOIST 5YR 4/4; SILT LOAM; WEAK TO MODERATE, FINE TO MEDIUM, GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; SLIGHTLY POROUS; BROKEN, ABRUPT HORIZON BOUNDARY.

BFU: 9 TO 15 CM, RANGE 0 TO 12 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/8, MATRIX MOIST 7.5YR 5/6; SILT LOAM; MODERATE, MEDIUM, GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; SLIGHTLY POROUS; BROKEN, ABRUPT HORIZON BOUNDARY.

AHB: 15 TO 16 CM, RANGE 1 TO 8 CM; HORIZON MOIST; MATRIX MOIST 10YR 3/3; SILT LOAM; MODERATE, MEDIUM, GRANULAR STRUCTURE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; BROKEN, ABRUPT HORIZON BOUNDARY.

BC: 16 TO 46 CM, RANGE 23 TO 42 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 6/2; SILT LOAM; WEAK, MEDIUM TO COARSE, SUBANGULAR BLOCKY STRUCTURE; WEAK, FINE, PLATY SECONDARY STRUCTURE; FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE ROOTS; 60% SLATY COARSE FRAGMENTS; WAVY, DIFFUSE HORIZON BOUNDARY.

C: 46 TO 83 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 6/2; LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; MICRO AND VERY FINE ROOTS; 80% SLATY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF								
AHEU	4.0	12.0	36.2		1.4	0.3	0.1	0.4
BHFU	4.4	0.8	50.0		0.4	0.1	0.1	0.1
BFU	4.8	4.2	39.6		1.1	0.1	0.1	0.1
AHB								
BC	4.6		4.8		0.4	0.1	-.1	-.1
C	5.1		3.8		1.0	0.1	-.1	-.1

HORIZON	EXTRACT IRON (%) 1	2	EXTRACT ALUMINUM (%) 1	2	EXTR MN (%)
LF					
AHEU					
BHFU	1.0		1.1		-.1
BFU	0.3		0.5		0.0
AHB					
BC					
C					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LF														
AHEU										17		67	16	
BHFU										20		68	12	
BFU										26		68	6	
AHB														
BC										35		57	8	
C	99	94	74	53						45		47	8	

ENGINEERING

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AHEU													
BHFU													
BFU													
AHB													
BC													
C		26.5	4.0			30	33						07

Table D23. Pedon (Alberta 1978 No. 96) illustrating Eluviated Dystric Brunisols of the LV Ecosection.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ELUVIATED DYSTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: LV1.

LOCATION: MILITARY GRID REF. 11 UNG 5940 8700; NTS MAP AREA 82N 8E.

CLIMATE: 2350 METERS ABOVE MEAN SEA LEVEL. STATION AT LAKE LOUISE HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 1 DEG(C) AT 50 CM IN OCTOBER.

VEGETATION: VPN=JE8157*VTN=C23*.

SOIL SITE: PARENT MATERIAL 1: MODERATE CHEMICAL WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY), UNDIFFERENTIATED, EOLIAN; PARENT MATERIAL 2: UNSPECIFIED WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), MORAINAL (TILL), QUARTZITE; LANDFORM CLASSIFICATION: MORAINAL, BLANKET; SLOPE: 47% SIMPLE SLOPE OF CLASS 8 (46-70%), FACING WEST, SITE AT MIDDLE POSITION, SLIGHTLY MOUNDED MICROTOPOGRAPHY,400 M LONG; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, RAPIDLY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; VERY STONY; NONROCKY.

SPECIAL NOTES: SSN=BH0143$APN=783-62*RLU=15*SSC=ST*PCF=1CB,1ST(1-3)4GR,2CB,1ST(4-5)5GR,3CB,3ST(6-7)*AHE HORIZON IS DISTURBED BY FIRE,AVALANCHING,OR MASS WASTING;INCLUDES SOME B MATERIAL*LFH=MB/RI*

LFH: 2 TO 0 CM, RANGE 1 TO 3 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/1; ABUNDANT, VERY FINE AND FINE AND MEDIUM ROOTS; 10% COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

AHE: 0 TO 7 CM, RANGE 6 TO 10 CM; HORIZON MOIST; MATRIX MOIST 10YR 4/3.5, MATRIX MOIST 10YR 3/4; SILT LOAM, VERY WEAK, FINE TO MEDIUM, PLATY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, VERY FINE AND FINE AND MEDIUM ROOTS; 10% COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BHF: 7 TO 11 CM, RANGE 0 TO 7 CM; HORIZON MOIST; MATRIX MOIST 5YR 4/6, MATRIX MOIST 5YR 4/4; SILT LOAM; VERY WEAK, FINE TO MEDIUM, GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, VERY FINE AND FINE AND MEDIUM ROOTS; 10% COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; BROKEN, ABRUPT HORIZON BOUNDARY.

2BM: 11 TO 16 CM, RANGE 0 TO 10 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/6; LOAMY SAND; STRUCTURELESS, SINGLE GRAIN STRUCTURE; LOOSE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE ROOTS; 40% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; BROKEN, ABRUPT HORIZON BOUNDARY.

2BC1: 16 TO 41 CM, RANGE 19 TO 40 CM; HORIZON MOIST; MATRIX MOIST 10YR 6/3.5; LOAMY SAND, STRUCTURELESS, SINGLE GRAIN STRUCTURE, LOOSE CONSISTENCE; FEW, MICRO AND VERY FINE ROOTS; 40% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2BC2: 41 TO 61 CM, RANGE 18 TO 26 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/6; SAND; STRUCTURELESS, SINGLE GRAIN STRUCTURE; LOOSE CONSISTENCE; VERY FEW, MICRO AND VERY FINE ROOTS; 70% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2C: 61 TO 110 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4, MATRIX MOIST 10YR 4/4; SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE, FRIABLE CONSISTENCE; VERY FEW, MICRO AND VERY FINE ROOTS; 70% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LFH	4.7	32.70						
AHE	4.4	3.70	21.6		1.3	0.4	0.1	0.2
BHF	4.8	5.90	35.3		1.3	0.4	0.1	0.1
2BM	4.8	1.30	6.3		0.7	0.2	-.1	-.1
2BC1	4.4		2.6		0.2	0.1	0.0	-.1
2BC2	4.5		2.2		0.4	0.1	-.1	-.1
2C	4.4		2.2		0.3	0.1	-.1	-.1

CHEMICAL DATA (SURVEY)

HORIZON	EXTRACT IRON (%) 1	2	EXTRACT ALUMINUM (%) 1	2
LFH				
AHE				
BHF	0.5		0.7	
2BM	0.1		0.1	
2BC1				
2BC2				
2C				

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LFH														
AHE					1	1	1	14	10	27		65	8	
BHF					1	1	2	4	10	18		75	7	
2BM					9	12	20	30	8	79		18	3	
2BC1					5	9	17	38	12	81		17	2	
2BC2					10	11	18	37	12	88		12	0	
2C	99	71	52	44	7	10	11	21	12	61		34	5	

PHYSICAL DATA

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ENGINEERING ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LFH													
AHE		44.4	19.1										
BHF													
2BM		10.3	5.2										
2BC1													
2BC2		4.4	1.3									12	87
2C		11.1	1.8										

Table D24. Pedon (Alberta 1977 No. 92) describing a Cumulic Regosol of the PL1 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC EUTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: PL1.

LOCATION: MILITARY GRID REF. 11 UNG 7380 9390; NTS MAP AREA 82O SW.

CLIMATE: 2150 ABOVE MEAN SEA LEVEL. STATION AT LAKE LOUISE HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 4 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VTN=C15*.

SOIL SITE: PARENT MATERIAL 1: FINE LOAMY AND FINE SILTY (18 TO 35% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), EOLIAN; PARENT MATERIAL 2: COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY CALCAREOUS (>40% CACO3), MORAINAL (TILL); LANDFORM CLASSIFICATION: MORAINAL, BLANKET; SLOPE: 58% SIMPLE SLOPE OF CLASS 8 (46-70%), FACING SOUTHWEST, SITE AT UPPER SLOPE POSITION, SLIGHTLY MOUNDED MICROTOPOGRAPHY,100 M LONG; SOIL MOISTURE AND DRAINAGE: MODERATELY WELL DRAINED, SLOWLY PERVIOUS, RAPID SURFACE RUNOFF, SEEPAGE ABSENT; SLIGHTLY STONY; NONROCKY.

SPECIAL NOTES: SSN=GC7056*APN=783-104*RLU=15*WLU=B2*SSC=CB*PCF=1GR(2)2GR,1CB(3)3GR,2CB(4-5)*ABUNDANT WHITE MYCELIA IN FH*LARGE DECOMPOSED ROOT NEAR BOTTOM OF BM*2CK2 SAMPLED FROM 105 TO 110CM*LFM=MB/RI*

FH: 101 TO 201 CM, RANGE 1 TO 2 CM; HORIZON MOIST; NATURAL WET/OXIDIZED 5YR 2.5/1; SMOOTH, ABRUPT HORIZON BOUNDARY.

BM: 0 TO 20 CM, RANGE 15 TO 23 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/5; SILTY CLAY LOAM; MODERATE, FINE, GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, FINE AND MEDIUM ROOTS; FEW, FINE PORES; GRAVELLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2BCK: 20 TO 32 CM, RANGE 10 TO 15 CM; HORIZON MOIST; MATRIX MOIST 10YR 4/4; SILTY CLAY LOAM; WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; MODERATE, FINE, GRANULAR SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MEDIUM ROOTS; FEW, FINE PORES; WEAK EFFERVESCENCE; WEAKLY CALCAREOUS; GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2CK1: 32 TO 70 CM, RANGE 33 TO 43 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/3; SILT LOAM; MASSIVE STRUCTURE; WEAK, MEDIUM, SUBANGULAR BLOCKY SECONDARY STRUCTURE PSEUDO; FRIABLE CONSISTENCE; FEW, MEDIUM ROOTS; COMMON, FINE PORES; FEW, VERY THIN CLAY FILMS IN VOIDS AND/OR CHANNELS ONLY; MODERATE EFFERVESCENCE; VERY STRONGLY CALCAREOUS; GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

2CK2: 70 TO 110 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/3; SILT LOAM; MASSIVE STRUCTURE; FIRM CONSISTENCE; FEW, FINE PORES; FEW, VERY THIN CLAY FILMS IN VOIDS AND/OR CHANNELS ONLY; MODERATE EFFERVESCENCE; VERY STRONGLY CALCAREOUS; GRAVELLY AND COBBLY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
FH	5.7	37.3							
BM	5.2	2.7		19.7		12.1	1.0	0.1	0.3
2BCX	6.9		23.9						
2CK1	7.3		74.8						
2CK2	7.4		66.3						

HORIZON	EXTRACT IRON (%) 1	2	EXTRACT ALUMINUM (%) 1	2
FH				
BM	0.3		0.1	
2BCX				
2CK1				
2CK2				

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
FH															
BM										8		63	29	9	1.2
2BCX										16		56	28	10	1.3
2CK1										37		50	13	5	2.2
2CK2	99	72	58	52						33		50	17	5	2.3

ENGINEERING

HORIZON	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
FH								
BM								
2BCX								
2CK1								
2CK2	12	17					40	18

Table D25. Pedon (Alberta 1978 No. 92) describing a Cumulic Regosol of the PP3 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: CUMULIC REGOSOL. SOIL MAP UNIT: NOTATION: PP3.

LOCATION: MILITARY GRID REF. 11 UNM 850 6560; NTS MAP AREA 83C 2W.

CLIMATE: 1440 METERS ABOVE MEAN SEA LEVEL. SOIL TEMP READING NO. 1 WAS 4 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VPN=JC0085*VTN=C13*..

SOIL SITE: PARENT MATERIAL 1: UNSPECIFIED WEATHERING, SANDY, EXTREMELY CALCAREOUS (>40% CACO3), FLUVIAL; LANDFORM CLASSIFICATION: FLUVIAL, FAN; SLOPE: 3% SIMPLE SLOPE OF CLASS 3 (2-5%), FACING SOUTHWEST, SITE AT MIDDLE POSITION, SLIGHTLY MOUNDED MICROTOPOGRAPHY,500 M LONG; SOIL MOISTURE AND DRAINAGE: MODERATELY WELL DRAINED, RAPIDLY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; NONSTONY; NONROCKY; PRESENT LAND USE: OUTDOOR RECREATION.

SPECIAL NOTES: SSN=BN0137*APN=010-200*RLU*15*PCF*5GR,3CB(5)60R,3CB,15T(6)*A+B HORIZON DOMINATED BY AH MATERIAL*.

LF: 6 TO 0 CM, RANGE 4 TO 13 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/2; ABUNDANT, FINE AND COARSE ROOTS; WAVY, ABRUPT HORIZON BOUNDARY.

BM: 0 TO 2 CM, RANGE 0 TO 5 CM; HORIZON MOIST; MATRIX MOIST 10YR 4/4; SILTY CLAY; VERY WEAK, FINE, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, FINE AND COARSE ROOTS; MODERATELY POROUS, COMMON, FINE AND MEDIUM PORES; BROKEN, ABRUPT HORIZON BOUNDARY.

C+AK: 2 TO 16 CM, RANGE 8 TO 16 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 3/2; SILT LOAM; VERY FRIABLE CONSISTENCE; PLENTIFUL, VERY FINE AND FINE ROOTS; MODERATELY POROUS, COMMON, VERY FINE AND FINE PORES; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; SMOOTH, ABRUPT HORIZON BOUNDARY.

CK1: 16 TO 29 CM, RANGE 8 TO 17 CM; HORIZON MOIST; MATRIX MOIST 10YR 3/2; VERY FINE SANDY LOAM; VERY FRIABLE CONSISTENCE; PLENTIFUL, VERY FINE AND FINE ROOTS; SLIGHTLY POROUS, FEW, MICRO PORES; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; WAVY, ABRUPT HORIZON BOUNDARY.

A+BBK: 29 TO 40 CM, RANGE 7 TO 15 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 3/2, MATRIX MOIST 5YR 3/3; GRAVELLY SILT LOAM; VERY FRIABLE CONSISTENCE; PLENTIFUL, VERY FINE AND FINE ROOTS; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 50% GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

CK2: 40 TO 100 CM; HORIZON MOIST; MATRIX MOIST 10YR 4/1, MATRIX MOIST 10YR 4/2; VERY GRAVELLY LOAMY SAND; LOOSE CONSISTENCE; VERY FEW, MICRO ROOTS; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 70% GRAVELLY AND COBBLY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%	C.E.C. (ME/100G) BUFF.	PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	3.0	48.40							
BM	5.0	4.00		37.4		10.1	6.3	-.1	0.3
C+AK	7.4		45.8						
CK1	7.4		76.7						
A+BBK	7.5		44.8						
CK2	7.7		79.3						

CHEMICAL DATA (SURVEY)

HORIZON	EXTRACT IRON (%) 1	2	EXTRACT ALUMINUM (%) 1	2
LF				
BM	0.6		0.1	
C+AK				
CK1				
A+BBK				
CK2				

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LF														
BM										1		58	41	
C+AK										12		68	20	
CK1	99	99	99	99			2	27	29	58		39	3	
A+BBK					8	8	6	7	5	34		51	15	
CK2	99	69	39	23	34	34	12	4	2	86		13	1	

PHYSICAL DATA

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	ENGINEERING OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
BM		33.7	21.5										
C+AK													
CK1		8.0	2.5									40	07
A+BBK													
CK2		3.7	1.4									11	02

Table D26. Pedon (Alberta 1982 No. 956) describing an Orthic Sombric Brunisol of the RD2 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC SOMBRIC BRUNISOL. SOIL MAP UNIT: NOTATION: RD2.

LOCATION: MILITARY GRID REF. 11 UNG 5180 7640; NTS MAP AREA 82N 1*.

CLIMATE: 2450 METERS ABOVE MEAN SEA LEVEL. STATION AT MARBLE CANYON HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 4 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VFN=HD2133*VTN=L05*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), MEDIUM ACID TO NEUTRAL (PH 5.6-7.3), COLLUVIAL, METAMORPHIC AND SLATE; LANDFORM CLASSIFICATION: COLLUVIAL, AVALANCHED AND SOLIFLUCTED, VENEER; SLOPE: 55% SIMPLE SLOPE OF CLASS 8 (46-70%), FACING SOUTHWEST, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, RAPID SURFACE RUNOFF, SEEPAGE ABSENT; MODERATELY STONY; SLIGHTLY ROCKY.

SPECIAL NOTES: SSN=WT2100*APN=BC5391-117*DATE=82/09/23*LFM=CV/RI-A,9*

LF: 2 TO 0 CM, RANGE 0 TO 3 CM; HORIZON MOIST; MATRIX MOIST 10YR 4/2; ANGULAR GRAVELLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

AH1: 0 TO 3 CM, RANGE 2 TO 4 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/2; LOAM; WEAK, MEDIUM, GRANULAR STRUCTURE; PLENTIFUL, FINE AND MEDIUM, RANDOM ROOTS; 20% ANGULAR GRAVELLY AND CHANNERY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

AH2: 3 TO 16 CM, RANGE 10 TO 16 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 3/2; VERY GRAVELLY SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY WEAK, FINE, GRANULAR SECONDARY STRUCTURE; PLENTIFUL, FINE AND MEDIUM, RANDOM ROOTS; 50% CHANNERY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BHF: 16 TO 20 CM, RANGE 3 TO 6 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 3/4, MATRIX MOIST 5YR 3/3; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FEW, FINE, RANDOM ROOTS; 50% CHANNERY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BM1: 20 TO 34 CM, RANGE 11 TO 22 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4; VERY GRAVELLY COARSE SANDY LOAM; STRUCTURELESS, SINGLE GRAIN STRUCTURE; FEW, VERY FINE AND FINE, RANDOM ROOTS; 60% ANGULAR GRAVELLY AND CHANNERY AND FLAGGY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BM2: 34 TO 43 CM, RANGE 8 TO 12 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/6; VERY GRAVELLY COARSE SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FEW, VERY FINE, RANDOM ROOTS; 70% ANGULAR GRAVELLY AND CHANNERY COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY; STRONGLY ACID 5.1-5.5 FIELD PH.

BC: 43 TO 83 CM, RANGE 35 TO 45 CM; HORIZON MOIST; MATRIX MOIST 10YR 6/4; VERY GRAVELLY COARSE SANDY LOAM; STRUCTURELESS, SINGLE GRAIN STRUCTURE; RANDOM ROOTS; 80% CHANNERY AND FLAGGY COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

C: 83 TO 110 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 6/4; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; MODERATELY POROUS, FEW, MEDIUM, RANDOM, CLOSED, VESICULAR PORES; 50% CHANNERY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	4.7	38.5						
AH1	4.8	17.0	51.8		15.4	1.3	1.2	0.8
AH2	4.7	9.9	40.2		4.3	0.3	0.3	0.2
BHF	4.9	10.5	58.5		4.0	0.2	0.3	0.1
BM1	5.3	2.1	15.5		2.3	0.2	0.4	0.1
BM2	5.2	1.4	14.9		0.7	-.1	0.3	0.1
BC	5.4		5.3		0.4	0.0	0.2	0.1
C	5.8							

HORIZON	EXTRACT IRON (%) 1	EXTRACT IRON (%) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2	EXTR MN (%)
LF					
AH1					
AH2					
BHF	0.6		1.9		-.1
BM1	0.2		0.4		-.1
BM2	0.1		0.2		-.1
BC					
C					

PHYSICAL DATA (SURVEY)

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	PARTICLE SIZE ANALYSIS % OF SAMPLE V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
LF															
AH1					11	16	7	5	4	43		46	11		
AH2					10	12	6	4	7	39		50	11		
BHF					1	4	3	3	10	21		64	15		
BM1					9	10	9	7	7	58		46	4		
BM2					21	16	4	4	12	57		41	2		
BC					14	27	8	3	4	56		42	2		
C	99	75	57	44	2	6	6	10	19	43		55	2		1.2

ENGINEERING

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AH1													
AH2													
BHF													
BM1													
BM2													
BC													
C		10.9	2.3			26	24						03

Table D27. Pedon (Alberta 1982 No. 972) describing an Orthic Eutric Brunisol of the SB6 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978. SUBGROUP: ORTHIC EUTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: SB6.

LOCATION: MILITARY GRID REF. 11 UNG 7350 1610; NTS MAP AREA 82J 12*.

CLIMATE: 1860 METERS ABOVE MEAN SEA LEVEL. STATION AT SINCLAIR PASS HAS MODERATE RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 2 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VPN=PA2044*VTN=C14*.

SOIL SITE: PARENT MATERIAL 1: SHATTERED AND WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND FINE LOAMY AND FINE SILTY (18 TO 35% CLAY), WEAKLY CALCAREOUS (1 TO 6% CACO3), COLLUVIAL, SHALE AND LIMESTONE; PARENT MATERIAL 2: FRACTURED AND WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND FINE LOAMY AND FINE SILTY (18 TO 35% CLAY), WEAKLY CALCAREOUS (1 TO 6% CACO3), RESIDUAL; DEPTH TO BEDROCK IS 0.6 M; LANDFORM CLASSIFICATION: COLLUVIAL, SOLIFLUCTED, VENEER; SLOPE: 75% SIMPLE SLOPE OF CLASS 9 (71-100%), FACING NORTHEAST, SITE AT MIDDLE POSITION, SLIGHTLY MOUNDED MICROTOPOGRAPHY, 500 M LONG; SOIL MOISTURE AND DRAINAGE: MODERATELY WELL DRAINED, SLOWLY PERVIOUS, RAPID SURFACE RUNOFF, SEEPAGE ABSENT; SLIGHTLY STONY; NONROCKY; PRESENT LAND USE: OUTDOOR RECREATION.

SPECIAL NOTES: SSN=BW2155*AFN=BC5490-238*LFM=CV/RUV/RI-S*LITHIC AND TURBIC PHASE*SOME BURIED AH MATERIAL IN UPPER TWO MINERAL HORIZONS*DATE=82/09/27*

LFH: 5 TO 0 CM, RANGE 4 TO 9 CM; MATRIX MOIST 10YR 2/2; FEW, FINE AND MEDIUM ROOTS; WAVY, ABRUPT HORIZON BOUNDARY.

AB: 0 TO 4 CM, RANGE 3 TO 5 CM; MATRIX MOIST 10YR 6/2, MATRIX MOIST 7.5YR 4/4; SILT LOAM; VERY WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, VERY FINE AND FINE AND MEDIUM ROOTS; 10% CHANNERY AND SHALY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BMU: 4 TO 21 CM, RANGE 10 TO 19 CM; MATRIX MOIST 7.5YR 4/4, MATRIX MOIST 10YR 5/3; SILT LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 20% CHANNERY AND SHALY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BM: 21 TO 26 CM, RANGE 4 TO 10 CM; MATRIX MOIST 7.5YR 5/6, MATRIX MOIST 10YR 5/6; GRAVELLY SILT LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, VERY FINE AND FINE ROOTS; 40% SHALY AND FLAGGY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BC: 26 TO 33 CM, RANGE 5 TO 15 CM; MATRIX MOIST 10YR 5.5/4; VERY GRAVELLY LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; STRUCTURELESS SECONDARY STRUCTURE; LOOSE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE ROOTS; WEAKLY CALCAREOUS; 60% SHALY AND FLAGGY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2BCK: 33 TO 63 CM, RANGE 27 TO 32 CM; MATRIX MOIST 10YR 6/4, 10YR 5/4; VERY GRAVELLY LOAM; STRUCTURELESS STRUCTURE; FIRM CONSISTENCE; STRONG EFFERVESCENCE; WEAKLY CALCAREOUS; 80% SHALY AND FLAGGY COARSE FRAGMENTS; WAVY, DIFFUSE HORIZON BOUNDARY.

R: 63 CM; STRONG EFFERVESCENCE.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LFH	4.0	40.1							
AB	4.0	3.6		26.2		5.7	1.0	-.1	0.1
BMU	5.0	2.7		25.1		9.8	0.6	0.1	0.1
BM	5.9	1.7		17.4		13.1	0.4	0.1	0.1
BC	6.5		1.2						
2BCK	6.8		3.9						
R									

HORIZON	EXTRACT IRON (%) 1	EXTRACT IRON (%) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2	EXTR MN (%)
LFH					
AB					
BMU	0.4		0.3		-.1
BM	0.2		0.2		-.1
BC					
2BCK					
R					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	% OF SAMPLE V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LFH														
AB										16		60	24	
BMU										29		53	18	
BM										33		53	14	
BC	99	57	41	23						37		44	19	
2BCK	99	53	34	14						41		39	20	
R														

ENGINEERING

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LFH													
AB													
BMU													
BM													
BC		29.2	9.8			40	46						03
2BCK		24.6	9.1			31	39						03
R													

Table D28. Pedon (Alberta 1982 No. 957) describing an Gleyed Ferro-Humic Podzol of the SX2 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978. SUBGROUP: GLEYED FERRO-HUMIC PODZOL. SOIL MAP UNIT: NOTATION: SX2.

LOCATION: MILITARY GRID REF. 11 UNG 5120 7520; NTS MAP AREA 82H 1*.

CLIMATE: 2010 METERS ABOVE MEAN SEA LEVEL. STATION AT MARBLE CANYON HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 3 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VPN=HD2134*VTN=009*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY), MEDIUM ACID TO NEUTRAL (PH 5.6-7.3), FLUVIAL; PARENT MATERIAL 2: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), MEDIUM ACID TO NEUTRAL (PH 5.6-7.3), MORAINAL (TILL), METAMORPHIC AND SLATE; LANDFORM CLASSIFICATION: MORAINAL, BLANKET; SLOPE: 20% COMPLEX SLOPE OF CLASS 6 (16-30%), FACING SOUTHWEST, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: IMPERFECTLY DRAINED, MODERATELY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE PRESENT; SLIGHTLY STONY; NONROCKY.

SPECIAL NOTES: SSN=WT2109*APN=BC5391-071*DATE=82/09/23*LFM=FV/MD/RI*

LF: 3 TO 0 CM, RANGE 1 TO 4 CM; HORIZON MOIST; MATRIX MOIST ; FEW, FINE, HORIZONTAL ROOTS; WAVY, CLEAR HORIZON BOUNDARY.

AH: 0 TO 4 CM, RANGE 2 TO 5 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 3/1; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, FINE, HORIZONTAL ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

BHF1: 4 TO 12 CM, RANGE 7 TO 10 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 3/3; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MEDIUM, HORIZONTAL ROOTS; 10% GRAVELLY COARSE FRAGMENTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

BHF2: 12 TO 19 CM, RANGE 3 TO 7 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/7; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MEDIUM, HORIZONTAL ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

BF: 19 TO 24 CM, RANGE 0 TO 6 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 3/3; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, FINE, HORIZONTAL ROOTS; 30% GRAVELLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2BFGJ: 24 TO 34 CM, RANGE 9 TO 12 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/5; SILT LOAM; COMMON, MEDIUM, FAINT, 7.5YR 5/6 MOTTLES; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, FINE, RANDOM ROOTS; 40% GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY; SLIGHTLY ACID 6.1-6.5 FIELD PH.

2CGJ1: 34 TO 55 CM, RANGE 18 TO 23 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 6/4; SILT LOAM; COMMON, MEDIUM, FAINT, 10YR 6/4 MOTTLES; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, FINE, RANDOM ROOTS; VERY FEW, FINE PORES; 50% GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS; WAVY, DIFFUSE HORIZON BOUNDARY.

2CGJ2: 55 TO 70 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 6/4; SILT LOAM; COMMON, MEDIUM, FAINT, 10YR 6/4 MOTTLES; STRUCTURELESS, MASSIVE STRUCTURE; FIRM CONSISTENCE; VERY FEW, FINE PORES 50% GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG.	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	5.5	30.1						
AH	5.5	16.3	43.2		44.0	1.1	0.6	0.3
BHF1	5.5	8.1	46.7		17.2	0.4	0.2	0.1
BHF2	5.7	7.6	41.4		16.6	0.4	0.1	0.1
BF	5.7	4.5	31.0		13.2	0.2	-.1	0.1
2BFGJ	5.8	1.7	12.9		6.7	0.1	-.1	0.1
2CGJ1	5.8		5.9		3.4	0.0	0.0	0.1
2CGJ2	6.0		4.2		2.7	0.0	0.0	0.1

HORIZON	EXTRACT IRON (%) 1	EXTRACT IRON (%) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2	EXTR MN (%)
LF					
AH					
BHF1	0.7		1.2		-.1
BHF2	0.4		0.9		-.1
BF	0.5		0.6		-.1
2BFGJ	0.3		0.3		-.1
2CGJ1					
2CGJ2					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BU[illegible] DE[illegible] G/CC
LF															
AH										19		64	17		
BHF1										21		64	15		
BHF2										19		76	5		
BF										26		64	10		
2BFGJ										28		61	11		
2CGJ1										36		56	8		
2CGJ2	99	92	73	59						29		56	15		1.9

ENGINEERING

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AH													
BHF1													
BHF2													
BF													
2BFGJ													
2CGJ1													
2CGJ2		24.2	4.3			21	26						17

Table D29. Pedon (Alberta 1978 No. 78) describing an Orthic Dystric Brunisol of the TK1 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC DYSTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: TK1.

LOCATION: MILITARY GRID REF. 11 UNG 8610 5380; NTS MAP AREA 82N 8E.

CLIMATE: 2560 METERS ABOVE MEAN SEA LEVEL. STATION AT LAKE LOUISE HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 4 DEG(C) AT 50 CM IN OCTOBER.

VEGETATION: VPN=JC0092*VTN=H1*.

SOIL SITE: PARENT MATERIAL 1: MODERATE CHEMICAL WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY), EOLIAN; PARENT MATERIAL 2: MODERATE CHEMICAL WEATHERING, SANDY, MEDIUM ACID TO NEUTRAL (PH 5.6-7.3), COLLUVIAL, QUARTZITE; LANDFORM CLASSIFICATION: COLLUVIAL, INCLINED; SLOPE: 60% SIMPLE SLOPE OF CLASS 8 (46-70%), FACING SOUTH, SITE AT MIDDLE POSITION, MODERATELY MOUNDED MICROTOPOGRAPHY,250 M LONG; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, RAPIDLY PERVIOUS, RAPID SURFACE RUNOFF, SEEPAGE ABSENT; EXCEEDINGLY STONY; SLIGHTLY ROCKY.

SPECIAL NOTES: SSN=NT0157*APN=703-61*R U=15*PCF=2AGR,1ACB(2)3AGR,2ACB(3)3AGR,3ACB,2ST(4)4AGR,4ACB,3ST(5)*

L: -2 TO 0 CM, RANGE 0 TO 3 CM; HORIZON MOIST; MATRIX MOIST ; FEW, COARSE ROOTS; WAVY, CLEAR HORIZON BOUNDARY.

AH: 0 TO 7 CM, RANGE 6 TO 9 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/1; SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; WEAK, VERY FINE, GRANULAR SECONDARY STRUCTURE; FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; WAVY, CLEAR HORIZON BOUNDARY.

BM: 7 TO 20 CM, RANGE 10 TO 23 CM; HORIZON MOIST; MATRIX MOIST 5YR 3/3; SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; IRREGULAR, CLEAR HORIZON BOUNDARY.

2BM: 20 TO 60 CM, RANGE 25 TO 35 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/5; SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; IRREGULAR, CLEAR HORIZON BOUNDARY; VERY STRONGLY ACID 4.6-5.0 FIELD PH.

2BC: 60 TO 112 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/5; GRAVELLY LOAMY SAND; STRUCTURELESS, MASSIVE STRUCTURE; LOOSE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE ROOTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
L	5.4	36.20						
AH	5.2	6.50	16.7		13.4	1.3	0.1	0.3
BM	4.7	3.10	8.2		1.9	0.3	-.1	0.1
2BM	4.8	1.30	4.1		0.9	0.2	-.1	-.1
2BC	6.3		1.7		3.2	0.2	-.1	-.1

CHEMICAL DATA (SURVEY)

HORIZON	EXTRACT IRON (%) 1	2	EXTRACT ALUMINUM (%) 1	2
L				
AH				
BM	0.2		0.2	
2BM	0.2		0.1	
2BC				

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	% OF SAMPLE V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
L														
AH					5	16	26	14	4	65		26	9	
BM					10	14	24	17	4	69		27	4	
2BM					5	14	27	20	4	70		28	2	
2BC	99	49	8	3	9	17	34	21	4	85		15	0	

PHYSICAL DATA

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ENGINEERING ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY MG/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
L													
AH		20.9	22.4										
BM													
2BM													
2BC		6.6	2.1									11	02

Table D30. Pedon (Alberta 1982 No. 976) describing a Rego Gleysol of the VL2 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: REGO GLEYSOL. SOIL MAP UNIT: NOTATION: VL2.

LOCATION: MILITARY GRID REF. 11 UNG 6580 3770; NTS MAP AREA 82K 16*.

CLIMATE: 1210 METERS ABOVE MEAN SEA LEVEL. STATION AT KOOTENAY CROSSI HAS VERY GOOD RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 9 DEG(C) AT 20 CM IN SEPTEMBER, NO. 2 WAS 8 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VPN=MF2137*VTN=S01*..

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, STRATIFIED (MINERAL AND ORGANIC), MODERATELY TO VERY STRONGLY CALCAREOUS (6-40% CACO3), FLUVIAL, SEDIMENTARY; PARENT MATERIAL 2: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), MODERATELY TO VERY STRONGLY CALCAREOUS (6-40% CACO3), GLACIOFLUVIAL; LANDFORM CLASSIFICATION: FLUVIAL, LEVEL; SLOPE: 1% SIMPLE SLOPE OF CLASS 2 (0.5-2%), FACING SOUTHEAST, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: POORLY DRAINED, SLOWLY PERVIOUS, SLOW SURFACE RUNOFF, SEEPAGE PRESENT, 0.5 M TO APPARENT WATERTABLE; NONSTONY; NONROCKY.

SPECIAL NOTES: SSN=DA2120*APN=BC5490-214*DATE=82/09/21*LFM=FV/FGL*

OF: 11 TO 4 CM, RANGE 3 TO 8 CM; HORIZON MOIST; MATRIX MOIST 5YR 3/2; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

OH: 4 TO 0 CM, RANGE 2 TO 7 CM; HORIZON MOIST; MATRIX MOIST 5YR 2.5/1; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; BROKEN, ABRUPT HORIZON BOUNDARY.

C+O: 0 TO 9 CM, RANGE 5 TO 12 CM; HORIZON MOIST; MATRIX MOIST 5Y 6/2, MATRIX MOIST 10YR 4/1; SILTY CLAY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; WEAKLY CALCAREOUS; WAVY, ABRUPT HORIZON BOUNDARY.

AH: 9 TO 16 CM, RANGE 4 TO 9 CM; HORIZON MOIST; MATRIX MOIST 10YR 3/1; SILTY CLAY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; WEAKLY CALCAREOUS; SMOOTH, ABRUPT HORIZON BOUNDARY.

CKG1: 16 TO 20 CM, RANGE 10 TO 14 CM; HORIZON MOIST; MATRIX MOIST 5Y 5/1; SILT LOAM; FEW, FINE, PROMINENT, 10YR 7/6 MOTTLES; COMMON, COARSE, PROMINENT, 7.5YR 6/6 MOTTLES; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; WEAK EFFERVESCENCE; WEAKLY CALCAREOUS; SMOOTH, ABRUPT HORIZON BOUNDARY.

CKG2: 20 TO 40 CM, RANGE 18 TO 22 CM; HORIZON WET; MATRIX MOIST 2.5Y 6/4; SILT LOAM; COMMON, COARSE, PROMINENT, 7.5YR 5/8 MOTTLES; STRUCTURELESS, MASSIVE STRUCTURE; STICKY CONSISTENCE; STRONG EFFERVESCENCE; WEAKLY CALCAREOUS; WAVY, CLEAR HORIZON BOUNDARY.

CKG3: 40 TO 61 CM, RANGE 13 TO 18 CM; HORIZON WET; MATRIX MOIST 5Y 6/3; GRAVELLY SILT LOAM; MANY, MEDIUM, PROMINENT, 7.5YR 5/8 MOTTLES; STRUCTURELESS, MASSIVE STRUCTURE; STICKY CONSISTENCE; STRONG EFFERVESCENCE; STRONGLY CALCAREOUS; 50% GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

CKG4: 61 TO 70 CM, RANGE 8 TO 12 CM; HORIZON WET; MATRIX MOIST 5Y 6/3; SILT LOAM; MANY, MEDIUM, PROMINENT, 7.5YR 5/8 MOTTLES; STRUCTURELESS, MASSIVE STRUCTURE; STICKY CONSISTENCE; STRONG EFFERVESCENCE; STRONGLY CALCAREOUS; SMOOTH, CLEAR HORIZON BOUNDARY.

2CK: 70 TO 82 CM; HORIZON WET; VERY GRAVELLY COARSE SANDY LOAM; STRUCTURELESS, SINGLE GRAIN STRUCTURE; NONSTICKY CONSISTENCE; STRONG EFFERVESCENCE; VERY STRONGLY CALCAREOUS; 80% GRAVELLY AND COBBLY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

				C.E.C. (ME/100G)		EXCHANGEABLE CATIONS BUFFERED (ME/100G)			
HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%	BUFF.	PERM. CHARG	CA	MG	NA	K
OF	6.7	31.9							
OH	6.6	20.9							
C+O	6.6	6.6	0.9	43.3		30.5	5.0	0.0	0.1
AH	6.6	12.3	0.7	64.5		56.5	6.8	-.1	0.1
CKG1	6.9	2.5	0.7						
CKG2	7.3	0.8	0.6						
CKG3	7.4	0.2	15.6						
CKG4	7.5	0.0	10.5						
2CK	7.4	0.5	29.4						

PHYSICAL DATA (SURVEY)

	% PASSING				PARTICLE SIZE ANALYSIS						% OF SAMPLE				
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	20-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
OF															
OH															
C+O										1		69	30		
AH										1		67	32		
CKG1										1		75	24		
CKG2					0	1	1	1	2	5		78	17		
CKG3					2	4	3	5	6	20		68	12		
CKG4	99	99	99	99	0	1	2	7	9	19		69	12		1.7
2CK	99	78	43	24	14	17	11	10	7	59		38	3		

	MOISTURE STATUS (%)					ENGINEERING							
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
OF													
OH													
C+O													
AH													
CKG1													
CKG2													
CKG3													
CKG4		30.0	5.5			25	31						09
2CK		19.9	3.4			20	29						03

Table D31. Pedon (Alberta 1982 No. 961) describing an Orthic Eutric Brunisol of the WF3 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC EUTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: WF3.

LOCATION: MILITARY GRID REF. 11 UNG 7980 2540; NTS MAP AREA 82J 13*.

CLIMATE: 2170 METERS ABOVE MEAN SEA LEVEL. STATION AT SINCLAIR PASS HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 4 DEG(C) AT 40 CM IN SEPTEMBER.

VEGETATION: VPN=HD2138*VTN=004*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, FRAGMENTAL (STONES,COBBLES AND GRAVEL) AND SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY CALCAREOUS (>40% CACO3), COLLUVIAL, MIXED; DEPTH TO BEDROCK IS 0.4 M; LANDFORM CLASSIFICATION: COLLUVIAL, VENEER; SLOPE: 80% SIMPLE SLOPE OF CLASS 9 (71-100%), FACING WEST, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, RAPIDLY PERVIOUS, RAPID SURFACE RUNOFF, SEEPAGE PRESENT; VERY STONY; MODERATELY ROCKY.

SPECIAL NOTES: SSN=MT2193*APN=BC5490-218*DATE=82/09/27* LFN=CV/RI*SEEPAGE ALONG BEDROCK SURFACE AT PRESENT* BCK2 FRAGMENTAL, NO SAMPLE* LITHIC PHASE PEDON*

LF: 2 TO 0 CM, RANGE 0 TO 3 CM; HORIZON MOIST; FEW ROOTS; 30% ANGULAR GRAVELLY AND CHANNERY AND ANGULAR COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

AHK: 0 TO 4 CM, RANGE 3 TO 7 CM; HORIZON MOIST; MATRIX MOIST 10YR 3/3; GRAVELLY SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM, RANDOM ROOTS; STRONG EFFERVESCENCE; VERY STRONGLY CALCAREOUS; 50% ANGULAR GRAVELLY AND CHANNERY AND ANGULAR COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BMK: 4 TO 17 CM, RANGE 9 TO 15 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 4/4; GRAVELLY SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, FINE AND MEDIUM, RANDOM ROOTS; STRONG EFFERVESCENCE; WEAKLY CALCAREOUS; 50% ANGULAR GRAVELLY AND CHANNERY AND ANGULAR COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BCK1: 17 TO 38 CM, RANGE 10 TO 30 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/4, MATRIX MOIST 7.5YR 6/6; VERY GRAVELLY SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; LOOSE CONSISTENCE; FEW, FINE AND MEDIUM, RANDOM ROOTS; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 70% ANGULAR GRAVELLY AND CHANNERY AND ANGULAR COBBLY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BCK2: 38 TO 43 CM, RANGE 3 TO 14 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 6/6; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; LOOSE CONSISTENCE; VERY FEW, FINE, RANDOM ROOTS; STRONG EFFERVESCENCE; 80% ANGULAR COBBLY AND FLAGGY COARSE FRAGMENTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

R: 43 CM

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%
LF	6.7	22.6	
AHK	6.9	7.4	36.6
BMK	7.0	6.6	3.8
BCK1	7.2		41.7
BCK2			
R			

HORIZON	EXTRACT IRON (%) 1	EXTRACT IRON (%) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2	EXTR MN (%)
LF					
AHK					
BMK	0.2		0.2		-.1
BCK1					
BCK2					
R					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	% PASSING .75" SIEVE	% PASSING NO.4 SIEVE	% PASSING NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 70-2U SILT	% OF SAMPLE 50-2U SILT	2U CLAY	0.2U CLAY
LF														
AHK										29		61	10	
BMK										17		70	13	
BCK1	99	92	50	26						40		52	8	
BCK2														
R														

ENGINEERING

HORIZON	MOISTURE STATUS (%) 0.1 ATM	MOISTURE STATUS (%) 0.33 ATM	MOISTURE STATUS (%) 15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AHK													
BMK													
BCK1		37.7	15.5			61	73						03
BCK2													
R													

Table D32. Pedon (Alberta 1982 No. 958) describing an Orthic Eutric Brunisol of the WH4 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC EUTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: WH4.

LOCATION: MILITARY GRID REF. 11 UNG 5760 6560; NTS MAP AREA 82N 1*.

CLIMATE: 2200 METERS ABOVE MEAN SEA LEVEL. STATION AT MARBLE CANYON HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 4 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VPN=HD2135*VTN=013*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), MEDIUM ACID TO NEUTRAL (PH 5.6-7.3), COLLUVIAL, SLATE; DEPTH TO BEDROCK IS 0.7 M; LANDFORM CLASSIFICATION: COLLUVIAL, VENEER; SLOPE: 80% SIMPLE SLOPE OF CLASS 9 (71-100%), FACING EAST, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, VERY RAPID SURFACE RUNOFF, SEEPAGE ABSENT; EXCEEDINGLY ROCKY.

SPECIAL NOTES: SSN=WT2190*APN=BC5391-070*DATE=82/09/24* LFM=CV/RI+RI*LITHIC PHASE PEDON*PH=6.1 AT 30 CM*

LF: 2 TO 0 CM, RANGE 3 TO 0 CM; HORIZON DRY; MATRIX MOIST 5YR 3/1.5, MATRIX MOIST 10YR 3/2; 10% CHANNERY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

AH: 0 TO 4 CM, RANGE 2 TO 5 CM; HORIZON DRY; MATRIX MOIST 10YR 4/3; SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE, RANDOM ROOTS; 50% ANGULAR GRAVELLY AND CHANNERY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BM1: 4 TO 19 CM, RANGE 11 TO 15 CM; HORIZON DRY; MATRIX MOIST 7.5YR 5/5; LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; PLENTIFUL, FINE AND MEDIUM AND COARSE, HORIZONTAL ROOTS; 60% ANGULAR GRAVELLY AND CHANNERY AND ANGULAR COBBLY COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

BM2: 19 TO 40 CM, RANGE 10 TO 24 CM; HORIZON DRY; MATRIX MOIST 10YR 5/4; COARSE SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MEDIUM AND COARSE, RANDOM ROOTS; 70% ANGULAR GRAVELLY AND CHANNERY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY; SLIGHTLY ACID 6.1-6.5 FIELD PH.

BC: 40 TO 71 CM, RANGE 0 TO 40 CM; HORIZON DRY; MATRIX MOIST 2.5Y 6/4; LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, FINE, VERTICAL ROOTS; 40% ANGULAR GRAVELLY AND CHANNERY COARSE FRAGMENTS; IRREGULAR, ABRUPT HORIZON BOUNDARY.

R: 71 CM

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	5.3	23.4						
AH	5.1	3.8	14.1		4.2	0.3	0.0	0.2
BM1	5.0	1.7	8.5		2.0	0.1	0.0	0.1
BM2	5.7	0.9	6.2		2.8	0.0	0.0	0.1
BC	6.2		5.1		3.0	0.0	0.0	-.1
R								

HORIZON	EXTRACT IRON (%) 1	EXTRACT IRON (%) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2	EXTR MN (%)
LF					
AH					
BM1	0.1		0.1		-.1
BM2	0.1		0.1		-.1
BC					
R					

PHYSICAL DATA (SURVEY)

HORIZON	% PASSING 3" SIEVE	% PASSING .75" SIEVE	% PASSING NO.4 SIEVE	% PASSING NO.10 SIEVE	PARTICLE SIZE ANALYSIS V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
LF															
AH					8	17	12	9	5	51		43	6		
BM1					6	17	12	10	6	51		42	7		
BM2					11	10	13	9	6	57		38	5		
BC	99	93	72	55	3	11	12	13	9	48		47	5		1.4
R															

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ENGINEERING ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AH													
BM1													
BM2													
BC		10.6	4.1			25	26						07
R													

Table D33. Pedon (Alberta 1982 No. 966) describing an Orthic Dystric Brunisol of the WH8 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC DYSTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: WH8.

LOCATION: MILITARY GRID REF. 11 UNG 4670 7500; NTS MAP AREA 82N 1*.

CLIMATE: 2390 METERS ABOVE MEAN SEA LEVEL. STATION AT MARBLE CANYON HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 3 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VPN=SD2136*VTN=D13*DATE=82/09/23*.

SOIL SITE: PARENT MATERIAL 1: SHATTERED AND WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), COLLUVIAL, SLATE; LANDFORM CLASSIFICATION: ACTIVE COLLUVIAL, AVALANCHED AND SOLIFLUCTED, BLANKET; SLOPE: 53% SIMPLE SLOPE OF CLASS 8 (46-70%), FACING SOUTHWEST, SITE AT MIDDLE POSITION, SLIGHTLY MOUNDED MICROTOPOGRAPHY,300 M LONG; SOIL MOISTURE AND DRAINAGE: MODERATELY WELL DRAINED, MODERATELY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; MODERATELY STONY; NONROCKY; PRESENT LAND USE: OUTDOOR RECREATION.

SPECIAL NOTES: SSN=BW2145*APN=BC5391-72*LFM=CB/RI-S,A*TURBIC PHASE;SOLIFLUCTION IS MAIN MODIFYING PROCESS,AVALANCHING MINOR; STREAKING OF COLORS + SORTING OF COARSE FRAGMENTS IN MID TO UPPER SOLUM*

H: 2 TO 0 CM, RANGE 1 TO 4 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/2; ABUNDANT, VERY FINE AND FINE AND MICRO ROOTS; WAVY, ABRUPT HORIZON BOUNDARY.

AHEU: 0 TO 7 CM, RANGE 6 TO 10 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 3/2, MATRIX MOIST 10YR 4/3; SILT LOAM; VERY WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY WEAK, VERY FINE, GRANULAR SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, VERY FINE AND MICRO ROOTS; 30% SLATY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BFU: 7 TO 16 CM, RANGE 7 TO 14 CM; HORIZON MOIST; MATRIX MOIST 10YR 3/4, MATRIX MOIST 5YR 3/4; SILT LOAM; VERY WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; WEAK, VERY FINE TO FINE, GRANULAR SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, VERY FINE AND MICRO ROOTS; 20% SLATY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BCU1: 16 TO 34 CM, RANGE 10 TO 24 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4, MATRIX MOIST 10YR 4/4; GRAVELLY SANDY LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, VERY FINE AND MICRO ROOTS; 50% SLATY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BCU2: 34 TO 48 CM, RANGE 13 TO 26 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4; GRAVELLY COARSE SANDY LOAM; VERY WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; STRUCTURELESS SECONDARY STRUCTURE; LOOSE CONSISTENCE; PLENTIFUL, VERY FINE AND MICRO ROOTS; 50% SLATY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY; STRONGLY ACID 5.1-5.5 FIELD PH.

BC: 48 TO 94 CM, RANGE 33 TO 52 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4; GRAVELLY SANDY LOAM; VERY WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; STRUCTURELESS SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO ROOTS; 70% SLATY AND FLAGGY COARSE FRAGMENTS; SMOOTH, GRADUAL HORIZON BOUNDARY.

C: 94 TO 115 CM; HORIZON MOIST; MATRIX MOIST 10YR 6/3; GRAVELLY COARSE SANDY LOAM; STRUCTURELESS STRUCTURE; LOOSE CONSISTENCE; VERY FEW, MICRO ROOTS; 70% SLATY AND FLAGGY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
H	4.0	24.5						
AHEU	4.4	6.2	19.1		2.4	0.5	0.0	0.4
BFU	4.3	4.5	20.7		0.6	0.0	0.0	0.1
BCU1	4.5		7.6		0.4	0.0	0.0	-.1
BCU2	4.0		4.7		0.3	0.0	0.0	0.0
BC	5.6		3.1		1.0	0.0	0.0	0.0
C	5.0		2.3		0.4	0.0	0.0	0.0

HORIZON	EXTRACT IRON (%) 1	2	EXTRACT ALUMINUM (%) 1	2	EXTR MN (%)
H					
AHEU					
BFU	0.7		0.7		-.1
BCU1					
BCU2					
BC					
C					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
H														
AHEU					4	9	7	8	7	35		50	7	
BFU					6	12	9	9	8	44		50	6	
BCU1					3	13	13	12	8	49		47	4	
BCU2					6	21	13	11	7	50		39	3	
BC					6	17	12	10	8	53		43	4	
C	99	84	50	30	12	22	13	10	6	63		33	4	

ENGINEERING

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
H													
AHEU													
BFU													
BCU1													
BCU2													
BC													
C		22.6	4.2			29	32						83

Table D34. Pedon (Alberta 1982 No. 974) describing an Orthic Eutric Brunisol of the WY1 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC EUTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: WY1.

LOCATION: MILITARY GRID REF. 11 UNG 6680 690; NTS MAP AREA 82K 9*.

CLIMATE: 990 METERS ABOVE MEAN SEA LEVEL. STATION AT RADIUM HAS GOOD RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 5 DEG(C) AT 50 CM IN MAY.

VEGETATION: VPN=PA2002*VTN=C01*..

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY), UNDIFFERENTIATED, EOLIAN, UNDIFFERENTIATED OR UNDETERMINED; PARENT MATERIAL 2: WEAK CHEMICAL WEATHERING, FINE LOAMY AND FINE SILTY (18 TO 35% CLAY), EXTREMELY CALCAREOUS (>40% CACO3), MORAINAL (TILL), SEDIMENTARY; LANDFORM CLASSIFICATION: GLACIO FLUVIAL AND MORAINAL, HUMMOCKY; SLOPE: 4% COMPLEX SLOPE OF CLASS 3 (2-5%), FACING NORTHWEST, SITE AT CREST POSITION; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; SLIGHTLY STONY; NONROCKY.

SPECIAL NOTES: SSN=DA2001*APN=BC5490-241*DATE=82/05/28* ROOT MATS IN 2CK2,CLR=7.5YR4/2(M)*AH NOT SAMPLED*TILL VERY COMPACT

LF: 5 TO 0 CM, RANGE 3 TO 6 CM; 10YR 3/2; ABUNDANT, FINE AND MEDIUM ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

AH: 0 TO 1 CM, RANGE 0 TO 3 CM; 10YR 4/2; SILT LOAM; VERY WEAK, FINE, GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, FINE AND MEDIUM ROOTS; BROKEN, ABRUPT HORIZON BOUNDARY.

BM: 1 TO 14 CM, RANGE 7 TO 16 CM; MATRIX MOIST 10YR 5/3.5; SILT LOAM; WEAK, FINE, PLATY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, FINE AND MEDIUM ROOTS; FEW PORES; WAVY, CLEAR HORIZON BOUNDARY.

2BM: 14 TO 29 CM, RANGE 14 TO 17 CM; MATRIX MOIST 10YR 6/5; SILT LOAM; VERY WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, FINE AND MEDIUM ROOTS; WEAKLY CALCAREOUS; 20% GRAVELLY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

2CK1: 29 TO 53 CM, RANGE 22 TO 29 CM; 10YR 7/4; LOAM; MODERATE, COARSE, SUBANGULAR BLOCKY STRUCTURE PSEUDO; FRIABLE CONSISTENCE; WEAKLY CEMENTEDBY LIME; FEW, VERY FINE AND FINE ROOTS; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 20% GRAVELLY AND ANGULAR GRAVELLY COARSE FRAGMENTS; WAVY, DIFFUSE HORIZON BOUNDARY.

2CK2: 53 TO 70 CM; 10YR 7/2; LOAM; MODERATE TO STRONG, VERY COARSE, PLATY STRUCTURE PSEUDO; FRIABLE CONSISTENCE; WEAKLY CEMENTED BY LIME; PLENTIFUL, MICRO AND VERY FINE AND FINE ROOTS; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 20% GRAVELLY AND ANGULAR GRAVELLY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	5.9	34.5							
AH									
BM	6.4	1.7		18.0		13.1	2.8	-.1	1.0
2BM	6.8	1.2	3.7						
2CK1	7.3		40.5						
2CK2	7.8		45.6						

HORIZON	EXTRACT IRON (%) 1	2	EXTRACT ALUMINUM (%) 1	2
LF				
AH				
BM	-.1		-.1	
2BM	-.1		-.1	
2CK1				
2CK2				

PHYSICAL DATA (SURVEY)

HORIZON	PARTICLE SIZE ANALYSIS % PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	% OF SAMPLE V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
LF															
AH															
BM										24		60	16		
2BM										33		51	16		
2CK1										33		45	22		
2CK2	99	95	81	58						28		47	25		1.9

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ENGINEERING ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AH													
BM													
2BM													
2CK1													
2CK2		19.9	10.2			22	31						08

Table D35. Pedon (Alberta 1982 No. 975) describing an Orthic Humic Regosol of southerly aspects of the WY2 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC HUMIC REGOSOL. SOIL MAP UNIT: NOTATION: WY2.

LOCATION: MILITARY GRID REF. 11 UNG 6820 490; NTS MAP AREA 82K 9*.

CLIMATE: 1000 METERS ABOVE MEAN SEA LEVEL. STATION AT RADIUM HAS GOOD RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 9 DEG(C) AT 20 CM IN MAY.

VEGETATION: VPN=MF2001*VTN=M19*..

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, FINE LOAMY AND FINE SILTY (18 TO 35% CLAY), MODERATELY TO VERY STRONGLY CALCAREOUS (6-40% CACO3), COLLUVIAL, SEDIMENTARY; PARENT MATERIAL 2: SKELETAL (>35% OF PARTICLES 2-25 CM) AND FINE LOAMY AND FINE SILTY (18 TO 35% CLAY), EXTREMELY CALCAREOUS (>40% CACO3), GLACIOFLUVIAL AND MORAINAL (TILL), SEDIMENTARY; LANDFORM CLASSIFICATION: GLACIO FLUVIAL AND MORAINAL, GULLIED, INCLINED; SLOPE: 55% SIMPLE SLOPE OF CLASS 8 (46-70%), FACING SOUTHWEST, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: RAPIDLY DRAINED, MODERATELY PERVIOUS, VERY RAPID SURFACE RUNOFF, SEEPAGE ABSENT; SLIGHTLY STONY; NONROCKY.

SPECIAL NOTES: SSN=DA2002*APN=BC5490-241* NO BULK DENSITY OR L HORIZON SAMPLES*CARBONATE RINDS ON FRAGMENTS ON SURFACE AND THROUGH OUT PROFILE*DATE=82/05/30*

L: 1 TO 0 CM, RANGE 0 TO 1 CM; STRONG EFFERVESCENCE; 30% GRAVELLY COARSE FRAGMENTS; BROKEN, ABRUPT HORIZON BOUNDARY.

AHK: 0 TO 20 CM, RANGE 17 TO 25 CM; MATRIX DRY 7.5YR 5/4; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; LOOSE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; STRONG EFFERVESCENCE; STRONGLY CALCAREOUS; 30% GRAVELLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2ACK: 20 TO 38 CM, RANGE 12 TO 23 CM; MATRIX DRY 10YR 6/3; GRAVELLY LOAM; MODERATE TO STRONG, COARSE, SUBANGULAR BLOCKY STRUCTURE PSEUDO; STRUCTURELESS, MASSIVE SECONDARY STRUCTURE; SLIGHTLY HARD CONSISTENCE; WEAKLY CEMENTEDBY LIME; PLENTIFUL, MICRO AND VERY FINE AND FINE ROOTS; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 40% GRAVELLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2CK: 38 TO 63 CM; MATRIX DRY 10YR 7/3; VERY GRAVELLY LOAM; MEDIUM TO COARSE, PLATY STRUCTURE PSEUDO; STRUCTURELESS, MASSIVE SECONDARY STRUCTURE; HARD CONSISTENCE; STRONGLY CEMENTEDBY LIME; FEW, MICRO AND VERY FINE AND FINE ROOTS; STRONG EFFERVESCENCE; EXTREMELY CALCAREOUS; 60% GRAVELLY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	TOTAL N (%)	CALC CARB EQU.%
L				
AHK	7.4	4.0	0.16	24.1
2ACK	7.5	2.1	0.07	47.4
2CK	7.5	1.3		46.5

PHYSICAL DATA (SURVEY)

	PARTICLE SIZE ANALYSIS													
	% PASSING										% OF SAMPLE			
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
L														
AHK										32		51	17	
2ACK										29		48	23	
2CK	99	86	69	53						29		47	24	

	MOISTURE STATUS (%)					ENGINEERING							
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
L													
AHK													
2ACK													
2CK		16.0	7.5			17	24						17

APPENDIX E - VEGETATION TYPES OF KOOTENAY NATIONAL PARK

CLOSED FOREST VEGETATION TYPES

C1: *Pseudotsuga menziesii/ Elymus innovatus*
(Douglas fir/hairy wild rye)

C3: *Pinus contorta/ Juniperus communis/ Arctostaphylos uva-ursi*
(lodgepole pine/juniper/bearberry)

C5: *Picea glauca-Pseudotsuga menziesii/ Hylocomium splendens*
(white spruce-Douglas fir/feathermoss)

C6: *Pinus contorta/ Shepherdia canadensis/ Aster conspicuus*
(lodgepole pine/buffaloberry/showy aster)

C9: *Pinus contorta/ Vaccinium caespitosum*
(lodgepole pine/dwarf bilberry)

C10: *Pinus contorta/ Alnus crispa/ Hylocomium splendens*
(lodgepole pine/green alder/feathermoss)

C11: *Pinus contorta-Picea* spp./ *Hylocomium splendens*
(lodgepole pine/feathermoss)

C13: *Picea engelmannii-Abies lasiocarpa/ Hylocomium splendens*
(Engelmann spruce-subalpine fir/feathermoss)

C14: *Picea engelmannii-Abies lasiocarpa/ Menziesia glabella/Vaccinium scoparium*
(Engelmann spruce-subalpine fir/false azalea)

C15: *Picea engelmannii-Abies lasiocarpa/Vaccinium scoparium*
(Engelmann spruce-subalpine fir/grouseberry)

C16: *Populus tremuloides/ Elymus innovatus-Lathyrus ochroleucus*
(aspen/hairy wild rye-peavine)

C18: *Pinus contorta/Shepherdia canadensis/Vaccinium scoparium*
(lodgepole pine/buffaloberry/grouseberry)

C19: *Pinus contorta/Shepherdia canadensis/ Linnaea borealis*
(lodgepole pine/buffaloberry/twinflower)

C20: *Pinus contorta/ Menziesia glabella/Vaccinium scoparium*
(lodgepole pine/false azalea/grouseberry)

C21: *Picea engelmannii-Abies lasiocarpa/Vaccinium membranaceum/Barbilophozia lycopodioides*
(Engelmann spruce-subalpine fir/tall bilberry/liverwort)

C22: *Populus tremuloides/Elymus innovatus-Aster conspicuus*
(aspen/hairy wild rye-showy aster)

C23: *Larix lyallii/Abies lasiocarpa/Vaccinium scoparium/Antennaria lanata*
(subalpine larch-subalpine fir/grouseberry-everlasting)

C25: *Picea engelmannii-Abies lasiocarpa/Alnus crispa/Vaccinium membranaceum/Dryopteris assimilis*
(Engelmann spruce-subalpine fir/green alder)

C28: *Populus balsamifera/Equisetum pratense*
(balsam poplar/horsetail)

C34: *Picea engelmannii/Abies lasiocarpa/Phyllodoce glanduliflora/Hylocomium splendens*
(Engelmann spruce-subalpine fir/heather/feathermoss)

C37: *Picea glauca/Shepherdia canadensis/Hylocomium splendens*
(white spruce/buffaloberry/feathermoss)

C38: *Pinus contorta/Shepherdia canadensis/Calamagrostis rubescens/Pleurozium schreberi*
(lodgepole pine/buffaloberry/pinegrass)

C39: *Pinus contorta/Shepherdia canadensis/Cornus canadensis/Pleurozium schreberi*
(lodgepole pine/buffaloberry/bunchberry)

C40: *Picea engelmannii-Abies lasiocarpa/Oplopanax horridum*/fern
(Engelmann spruce-subalpine fir/devil's club/fern)

C41: *Picea glauca-Abies lasiocarpa/Cornus canadensis-Equisetum arvense/Hylocomium splendens*
(white spruce-subalpine fir/bunchberry-horsetail)

C42: *Thuja plicata/Vaccinium ovalifolium*
(western red cedar/oval leaf blueberry)

C44: *Picea* spp.-*Populus tremuloides-Pinus contorta-*(*Betula papyrifera*)/*Shepherdia canadensis/Calamagrostis rubescens*
(spruce-aspen-lodgepole pine-(paper birch)/buffaloberry/pine grass)

C45: *Picea glauca-Larix occidentalis-Pseudotsuga menziesii/Cornus canadensis/Pleurozium schreberi*
(white spruce-western larch-Douglas fir/bunchberry)

OPEN FOREST VEGETATION TYPES

O4: *Picea engelmannii-Abies lasiocarpa-Pinus albicaulis-Pinus contorta*
(Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine)

O5: *Pseudotsuga menziesii/Juniperus communis/Arctostaphylos uva-ursi*
(Douglas fir/juniper/bearberry)

O6: *Picea engelmannii-Abies lasiocarpa/Salix* spp./*Aulacomnium palustre*
(Engelmann spruce-subalpine fir/willow/ribbed bog moss)

O9: *Picea engelmannii-Abies lasiocarpa/Valeriana sitchensis-Erigeron peregrinus*
(Engelmann spruce-subalpine fir/valerian-fleabane)

O10: *Picea engelmannii-Abies lasiocarpa/Phyllodoce glanduliflora-Cassiope mertensiana*
(Engelmann spruce-subalpine fir/heather)

O11: *Picea* spp./*Ledum groenlandicum/Tomenthypnum nitens*
(spruce/Labrador tea/brown moss)

O13: *Larix lyallii-Abies lasiocarpa/Cassiope mertensiana*
(subalpine larch-subalpine fir/heather)

O14: *Picea engelmannii-Abies lasiocarpa/Salix vestita/Pedicularis bracteosa*
(Engelmann spruce-subalpine fir/rock willow/bracted lousewort)

O24: *Pseudotsuga menziesii-Pinus ponderosa/Agropyron spicatum*
(Douglas fir-ponderosa pine/bluebunch wheatgrass)

SHRUB VEGETATION TYPES

S1: *Betula* spp.-*Potentilla fruticosa-Salix glauca/Tomenthypnum nitens*
(dwarf birch-shrubby cinquefoil-willow/brown moss)

S2: *Abies lasiocarpa-Salix* spp./*Valeriana sitchensis*
(subalpine fir-willow)

S4: *Salix* spp.-*Betula glandulosa/Erigeron peregrinus*
(willow-dwarf birch/fleabane)

S5: *Pinus contorta/Linnaea borealis-Epilobium angustifolium*
(lodgepole pine/twinflower-fireweed)

S8: *Salix barrattiana/Potentilla diversifolia*
(willow/cinquefoil)

S13: *Alnus crispa*/fern
(green alder/fern)

S16: *Populus tremuloides-Betula glandulosa/Arctostaphylos uva-ursi*
(aspen-dwarf birch/bearberry)

LOW SHRUB-HERB VEGETATION TYPES

L5: *Phyllodoce glanduliflora-Cassiope mertensiana-Antennaria lanata*
(heather-everlasting)

L7: *Salix arctica-Potentilla diversifolia*
(arctic willow-cinquefoil)

HERB-DWARF SHRUB VEGETATION TYPES

H1: *Dryas octopetala-Salix nivalis-Silene acaulis*
(mountain avens-snow willow-moss campion)

H2: *Carex nigricans-Antennaria lanata*
(black alpine sedge-everlasting)

H5: *Elymus innovatus-Fragaria virginiana-Epilobium angustifolium*
(hairy wild rye-wild strawberry-fireweed)

H8: *Dryas drummondii-Epilobium latifolium*
(yellow dryad-willow herb)

H11: *Carex aquatilis-Carex rostrata*
(water sedge-beaked sedge)

H12: Saxicolous lichen
(saxicolous lichen)

H16: *Erigeron peregrinus-Valeriana sitchensis*
(fleabane-valerian)

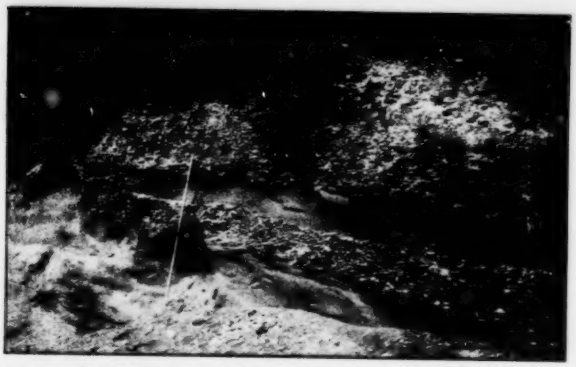
H17: *Antennaria lanata-Vaccinium scoparium*
(everlasting-grouseberry)

H19: *Agropyron spicatum-Elymus innovatus-Aster conspicuus*
(bluebunch wheatgrass-hairy wild rye-showy aster)

H22: *Epilobium angustifolium-Thalictrum occidentale*
(fireweed-meadow rue)

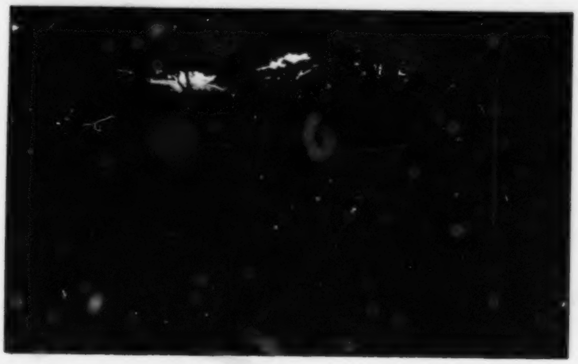
PLATES

COLOR
PLATES
1-73



1. Ice Contact Stratified Drift B in Stoddart Creek valley with extreme textural variability. Stick is 1 m long.

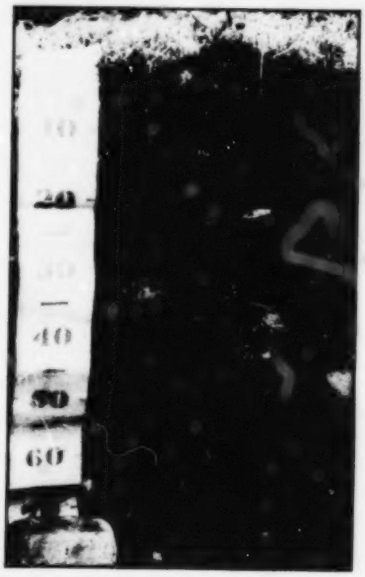
2. Mass movement of glaciolacustrine material on a steep slope along Ochre Creek.



7. Sparsely vegetated localities are a small proportion of BP2 and contain fragmental, weakly developed soils and nonsoil.

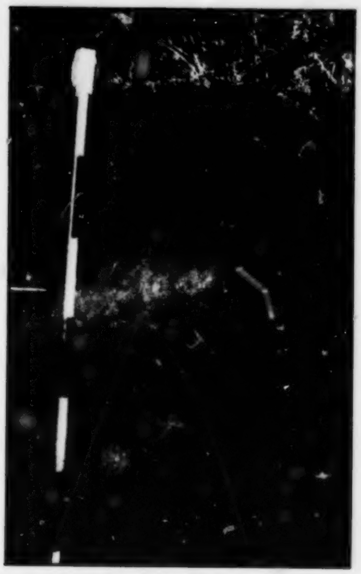
5. AT1 sample site with a young, even-aged lodgepole pine/buffaloberry/pine grass (C38) forest.

3. Sampled Eluviated Eutric Brunisol of the AL4 Ecosite.

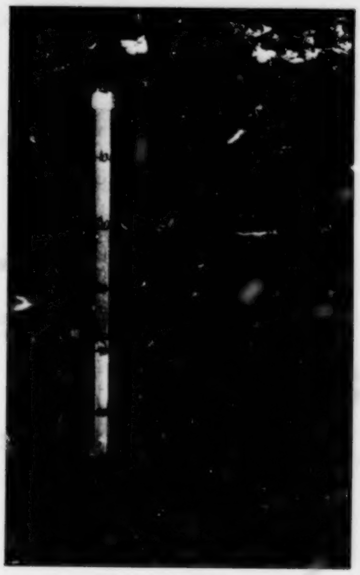


4. Sampled Orthic Eutric Brunisol of the AT1 Ecosite.

6. The landslide mapped as BP2 extends along the valley floor from Goodsir Pass (left) westward into YNP (right and background). Unvegetated talus plus rock glacier (middle, left to center) and blocky strips (middleground) mark the landslide boundary. Rockland (R) extends above the T + RG tract.



9. Sampled Orthic Eutric Brunisol (turbic phase) of the BS2 Ecosite.



11. Sampled Eluviated Eutric Brunisol of the BY6 Ecosite.

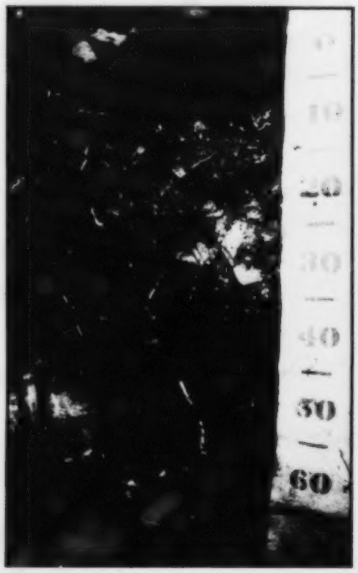
12. Sampled Eluviated Dystric Brunisol (turbic phase) of the CA2 Ecosite.

13. Orthic Humic Podzol of the CV1 Ecosite. Gleyed Ferro-Humic Podzols are more characteristic.

8. A typical BP2 site with subalpine larch-subalpine fir/grouseberry-everlasting (C23) forest and a bouldery surface.

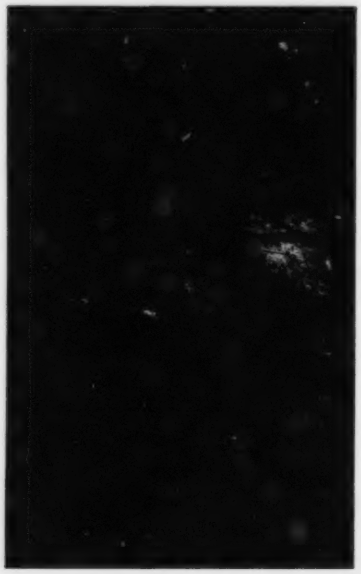
10. BS2 landscape with the everlasting-grouseberry (H17) v.t.

15. Sampled Orthic Eutric Brunisol (lithic phase) of the DG1 Ecosite.

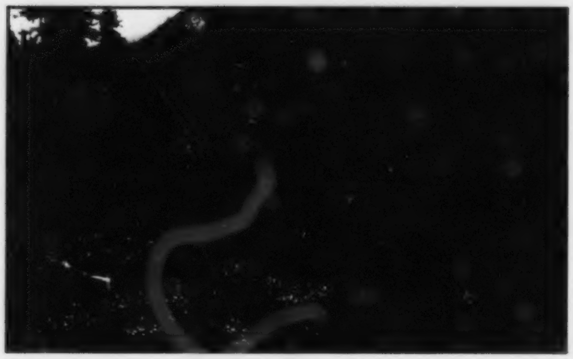


16. Sampled Orthic Regosol (lithic phase) of the DG3 Ecosite.

18. DG3 landscape with Douglas fir/juniper/-bearberry (O5) vegetation.



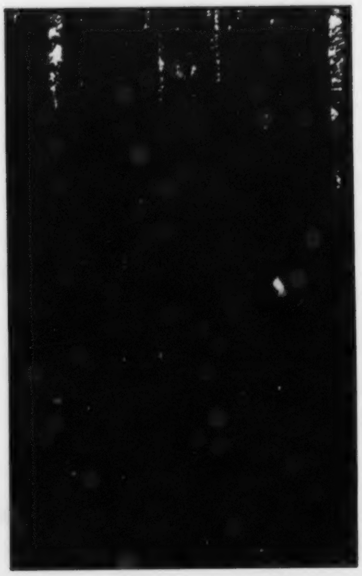
19. Douglas fir-ponderosa pine/wheatgrass (O24) open forest is restricted to DG3 and WY2 near the mouth of Stoddart Creek.



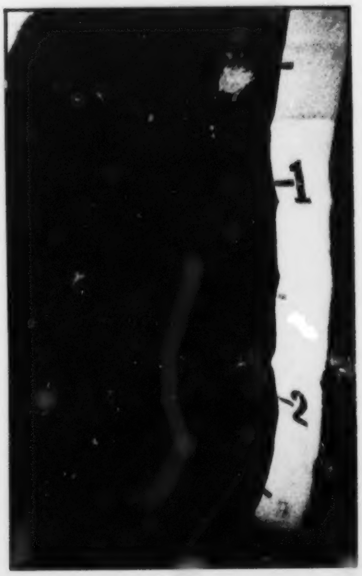
14. CV1 sample site with Engelmann spruce-subalpine fir/rock willow/bracted lousewort (O14) open forest.

17. Douglas fir/hairy wild rye (C1) v.t. typical of DG1 and DR1.

20. Sampled Orthic Gray Luvisol of the DR2 Ecosite.

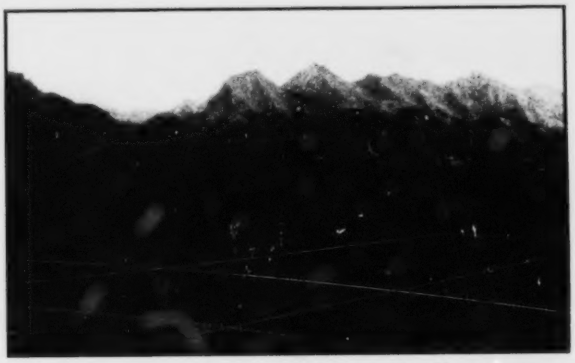


22. DR2 sample site with lodgepole pine/buffalo-berry/pine grass (C38) forest.



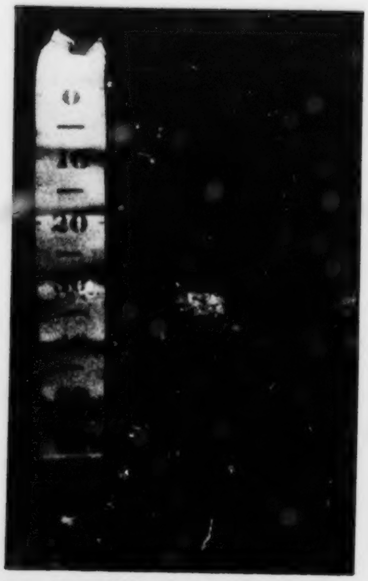
23. Sampled Orthic Humo-Ferric Podzol of the EF1 Ecosite.

24. A Dystric Brunisol, under subalpine larch forest typical of EG2, with a strongly eluviated Ahe horizon at the mineral surface.

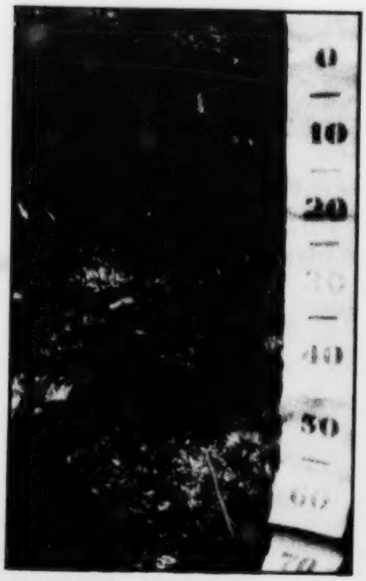


21. Light green forest patches on the Kootenay River valley wall contain aspen (C16 and C44 v.t.s) and are mapped as DR4.

25. Subalpine larch-subalpine fir/grouseberry-everlasting (C23) forest typical of EG2.

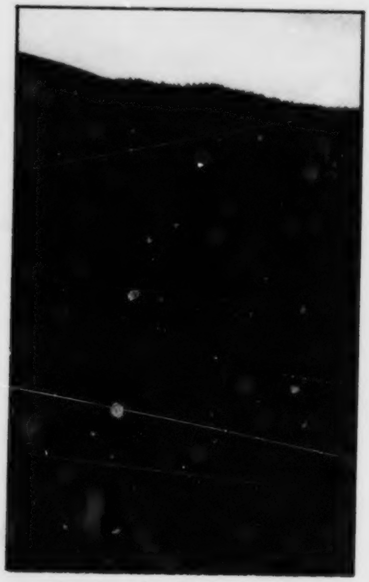


26. Sampled Orthic Eutric Brunisol of the FR1 Ecosite.

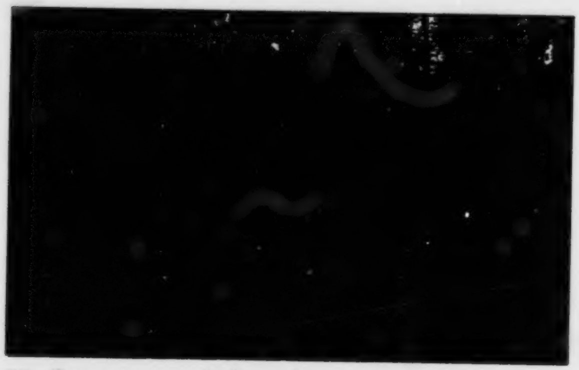


28. Sampled Eluviated Dystric Brunisol of the FV6 Ecosite.

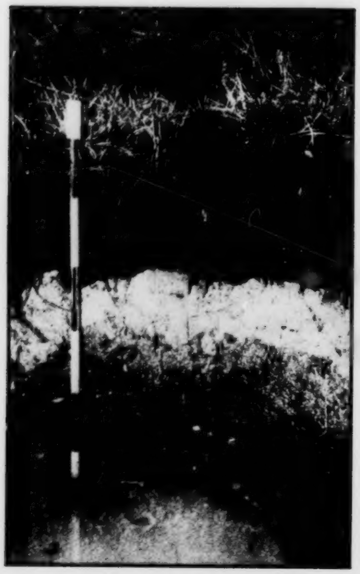
29. Sampled Orthic Humo-Ferric Podzol of the FV5 Ecosite.



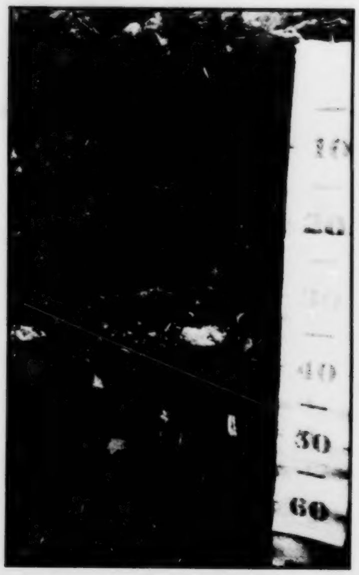
30. Avalanched FV5 terrain dominated by the green alder/fern (S13) v.t. on a colluvial apron.



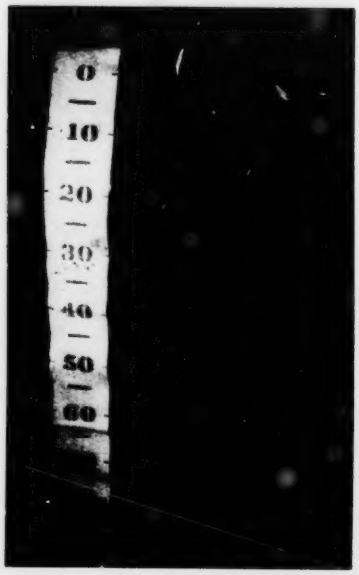
27. Spruce-aspen-lodgepole pine-(paper birch)/buffaloberry/pine grass (C44) mixedwood forest typical of FR3.



31. Sampled Rego Gleysol (peaty phase) of the HC1 Ecosite.



33. Sampled Cumulic Regosol of the HD3 Ecosite.

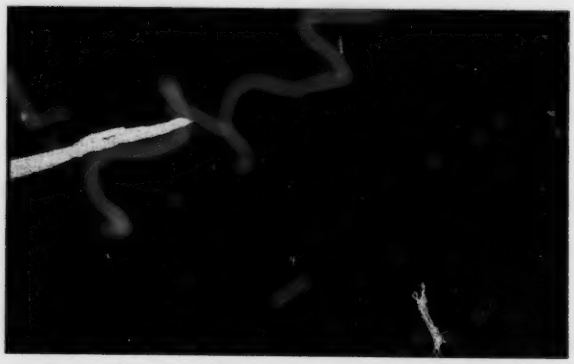


34. Sampled Orthic Regosol of the HD6 Ecosite.

32. HD6 on floodplains and recent terraces along the Vermilion River.

35. HD6 landscape with patches of yellow dryad-willow herb (H8) and other herb v.t.s interspersed with unvegetated sites.

36. Sampled Orthic Humic Regosol (lithic phase) of the HE2 Ecosite.

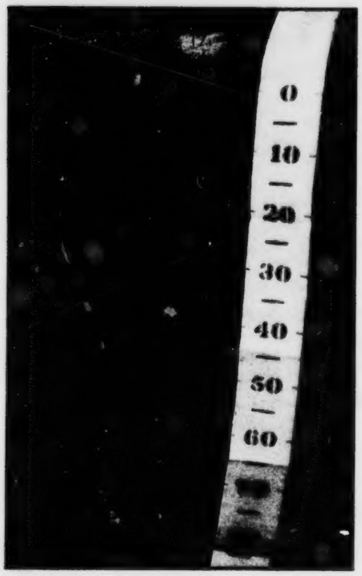


37. Sparsely vegetated, rocky terrain typical of the HE2 Ecosite.

38. Sampled Eluviated Dystric Brunisol of the IB4 Ecosite.

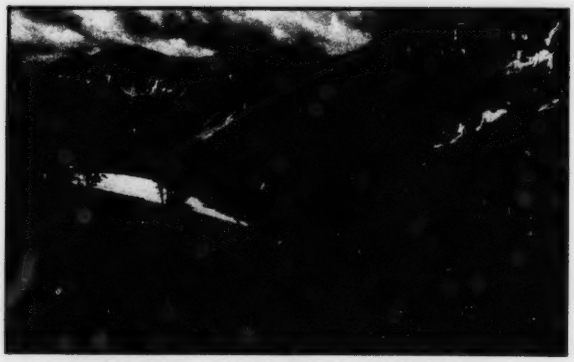
39. Sampled Orthic Humo-Ferric Podzol (turbic and lithic phases) of the JN1 Ecosite.

40. Severely soliflucted and cryoturbated pedon in the JN1F tract below Sharp Glacier.

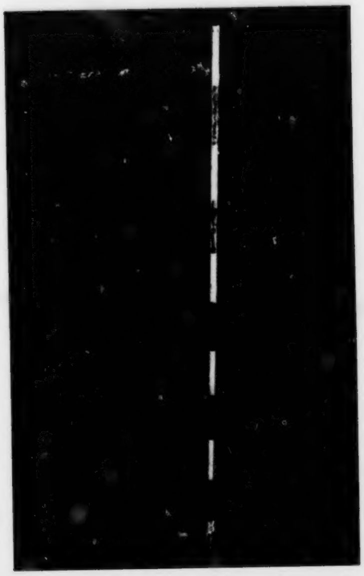


42. Sampled Eluviated Dystric Brunisol of the LV Ecosection.

41. Heather-everlasting (L5) vegetation is characteristic of the JN1, EF1, RD2 and TK1 Ecosites.



43. LV2 landscape with dominant heather-everlasting (L5, foreground) and subdominant sub-alpine larch-subalpine fir/heather (O13, middle ground) v.t.s.



44. Sampled Cumulic Regosol of the PP3 Ecosite.

45. Sampled Orthic Sombric Brunisol of the RD2 Ecosite.

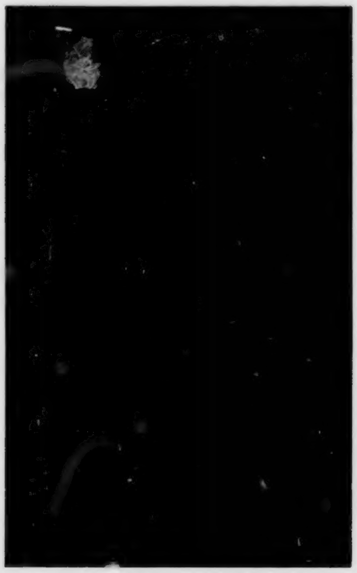
47. Sampled Orthic Eutric Brunisol (lithic and turbic phases) of the SB6 Ecosite.

48. Engelmann spruce-subalpine fir/false azalea (C14) forest, here on an SB6 tract, is extensive in the Lower Subalpine.

46. RD2 sample site with heather-everlasting (L5) vegetation.

49. Lodgepole pine/buffaloberry/showy aster (C6) v.t. on SB3.

51. Sampled Gleyed Ferro-Humic Podzol of the SX2 Ecosite.



54. Sampled Rego Gleysol (peaty phase) of the VL2 Ecosite.

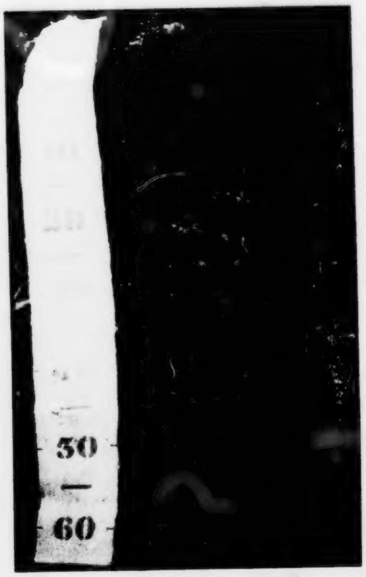
50. SB1 landscape with a mosaic of avalanche v.t.s. Aspen-dwarf birch/bearberry (S16) is in the foreground and dark green patches of subalpine fir-willow (S2) are near the valley floor.

52. A seepage-affected depression within an EG3 tract resembles SX1 and contains fleabane-valerian (H16) vegetation.

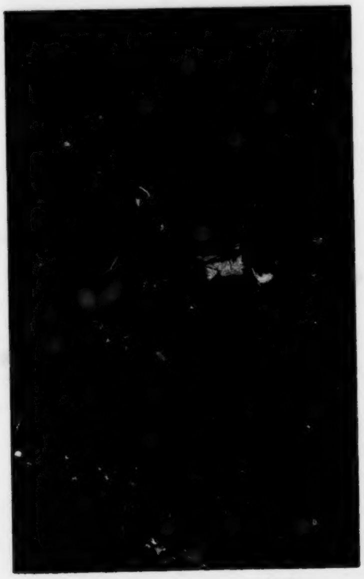
53. SX2 sample site with Engelmann spruce-subalpine fir/valerian-fleabane (O9) open forest.

57. Sampled Orthic Eutric Brunisol (lithic phase) of the WF3 Ecosite.

58. Engelmann spruce-subalpine fir/grouseberry (C15) forest is dominant on WF5 and subdominant on WF1.



60. Sampled Orthic Eutric Brunisol (lithic phase) of the WH4 Ecosite.

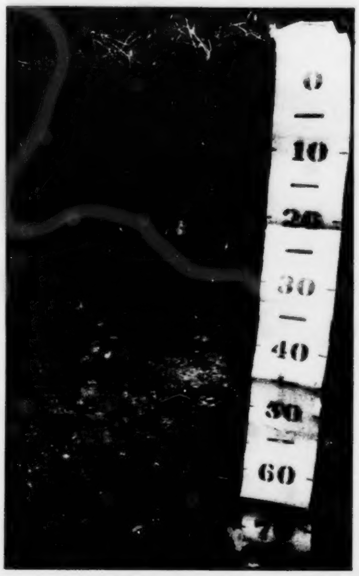


59. A grassy variant of the Englemann spruce-subalpine fir-whitebark pine-lodgepole pine (O4) v.t. occurs on WF3 tracts in the Western Ranges, particularly in upper John McKay Creek.

55. VL2 sample site with the dwarf birch-shrubby cinquefoil-willow/brown moss (S1) v.t.

56. White spruce-subalpine fir/bunchberry-horsetail (C41) is an accessory v.t. in VL6 where it occurs in channels.

63. Steep, craggy slopes dominated by Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4) open forest are typical of WH4.



64. Sampled Orthic Eutric Brunisol of the WY1 Ecosite.

0
10
20
30
40
50

65. Sampled Orthic Humic Regosol occurring under grassland on southerly aspects of WY2.

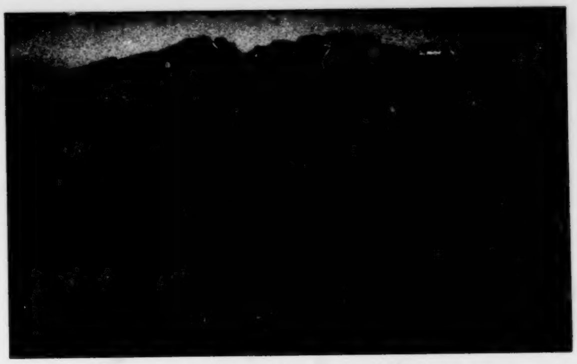
61. Landscape near Goodsir Pass with the subalpine larch forest of WH1 (middleground) below the herb and tundra vegetation of WH8 (background).

62. Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) forest dominates WH6.

66. WY1 sample site with Douglas fir/hairy wild rye (C1) forest.

67. Glacial benchland near Stoddart Creek with forest-open forest-grassland mosaic of WY2.

68. Bluebunch wheatgrass-hairy wild rye-showy aster (H19) grassland is common on WY2 and DG3 in southwestern KNP.

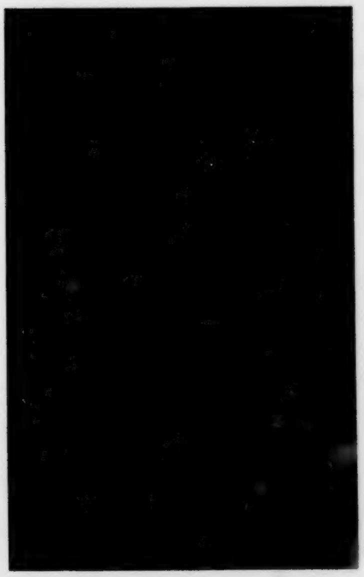


69. Modifier A (Avalanched) is added to an Ecosite symbol where 20 to 50% of the tract is modified by snow avalanching.

70. Effects of the 1968 fire on vegetation in the Vermilion Pass area. Modifier B (Burned) is added to an Ecosite symbol where ≥ 50% of the tract has been modified by recent fire.

71. Colluvial Rubble (CR) landscape with solifluction features. Subdued terrain is usually underlain by highly jointed, recessive bedrock. Here the bedrock is Chancellor Formation slate.

72. A steeply sloping Recent Moraine (M) below a small glacier (GL) near Tumbling Pass.



73. A Rock Glacier (RG) in East Verdant Creek valley.

Volume

2

Environment Canada   Environnement Canada

Ecological Land Classification of Kootenay National Park, British Columbia

Vol. II: Wildlife Resource

Authors: D.M. Poll, M.M. Porter, G.L. Holroyd, R.M. Wershler and L.W. Gyug

Canada

Cover

Map	Annotated air photo of Kootenay Crossing and vicinity.
Upper photo	Mountain goat and kid on limestone near Mt. Wardle. Photo by D.M. Poll.
Centre left	Pileated woodpecker. Photo by G.C. Trottier.
Centre right	Helmet Falls. Photo by P.L. Achuff.
Lower left	Eluviated Dystric Brunisol, CA2 Ecosite, below Vermilion Peak. Photo by W.S. Taylor.
Lower right	Indian paint brush (*Castilleja miniata*) in Vermilion burn near Stanley Glacier trail. Photo by B.D. Walker.

Ecological Land Classification
of
Kootenay National Park

Volume II **WILDLIFE RESOURCE**

David M. Poll, Marian M. Porter, Geoffrey L. Holroyd,
Ray M. Wershler and Les W. Gyug

Produced by
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The members of the land inventory team, led by Wil Holland, Canadian Forestry Service and Peter Achuff, Alberta Institute of Pedology, developed the land classification, helped extensively with field logistics, fostered a team spirit during field investigations and were always patient and cooperative with our questions.

Brock Fenton and Gray Merriam of Carleton University conducted bat surveys in Kootenay during July of 1981 and 1982. Their findings form the basis for discussions of bat species occurrence and distributions in this report.

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Christine Watts	volunteer	1983
Ray Wershler (RMW)	technician	1981 to 1984
Christine Wynyard	volunteer	1983

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[1] Initials following names are observer codes used in the computer files of wildlife inventory data, and are also used to reference specific sightings in the species accounts and other sections of this report.

1. INTRODUCTION

The Kootenay National Park (KNP) ecological (biophysical) land classification was developed from 1981 to 1984. The theory and methodology are similar to those of the ecological land classification of Banff and Jasper National Parks (Holland and Coen, eds. 1982, 1983; Holroyd and Van Tighem 1983). The classification is based on an integrated resource inventory in which all resource components (parent material, landform, soil, vegetation and wildlife) are dealt with together in a common land classification scheme at a 1:50,000 mapping scale.

The land resource was inventoried by the Canadian Forestry Service and the Alberta Institute of Pedology. Mainly soil scientists and botanists, this team collected data on landforms, soils and vegetation, developed the land classification, and produced the ecological maps of the **Map Supplement** that accompanies Volume I (Achuff *et al.* eds. 1984).

The wildlife resource was inventoried by the Canadian Wildlife Service, working closely with the land inventory team. The wildlife inventory team used a variety of sampling techniques to assess the distribution, abundance and habitat use of wildlife in the park, particularly with regard to wildlife use of Ecosites.

The **Map Supplement** which accompanies Volume I, delineates the distribution of Ecosites in KNP on two maps at a scale of 1:50,000. The Supplement includes an extended Map Legend which summarizes the characteristics of each Ecosite.

Volume I, Achuff *et al.* eds. (1984), includes all the information concerning methods, results and interpretations of the land inventory, and describes the land classification in detail. Wildlife information in Volume I includes:

Methods:
Brief descriptions of those sample methods used to provide data on the use of Ecosites by wildlife.

Species Assemblages:
Descriptions of characteristic assemblages of breeding birds and small mammals occurring in various habitats in the park.

Ecosite Accounts:
Wildlife use of each Ecosite and management considerations regarding wildlife are included in each Ecosite description.

This volume, **Volume II**, consists of the detailed report of the wildlife inventory team. Its contents and uses are described in the User's Guide below.

1.1. USERS' GUIDE TO VOLUME II

The purpose of this section is to direct you to the parts of our report that suit your interests or needs, and to show you how to use the information most effectively. As a user of this report you may be interested in learning about a certain species, finding out about certain habitats, or solving particular problems such as, "If I put a road or campground here, what effect will it have on wildlife? Where would be the place that I could do it with the least impact? How great a problem is highway mortality for ungulates ? How can I reduce this mortality?"

In other words, this report should be a basic tool for beginning to answer any question in KNP that relates to wildlife. It should also provide baseline information for park interpretation of wildlife and their habitats. Like any fairly technical report, though, it looks daunting to someone who did not work on it. It is less difficult than it looks, however.

First, what is your interest?

Do you wish to know about a certain species?

If so, your first stop should be the **Species Account** in Volume II. Here we have summarized all our data and all the information we could find from other sources about each species in the park. Each species account is broken down into several sections:

- Status and distribution
- Habitat
- Species Attributes
- Management Considerations

If the detail here is not enough, check the references to which we refer; they are all listed in the **Literature Cited** section at the end of the report.

If you are interested in additional information on a certain group of animals the following sections should be reviewed:
Amphibians: **Pond Surveys** Volume II, section 3.5.

Bats: **Bat Surveys** Volume II, section 3.12.

Birds: **Breeding Bird Communities** Volume I, chapter 4; **Circular Breeding Bird Plots** Volume II, section 3.1; **Breeding Bird Census Grids** Volume II, section 3.3; **Bird Migration** Volume II, section 3.2; **Pond Surveys** Volume II, section 3.5; **Owl Surveys** Volume II, section 3.4.

Carnivores: **Winter Tracking Transects** Volume II, section 3.10.

Small Mammals: **Small Mammal Associations** Volume I, chapter 4; **Winter Tracking Transects** Volume II, section 3.10; **Small Mammal Trapping** Volume II, section 3.11.

Ungulates: **Mt. Wardle Goat Study** Volume II, section 3.8; **Sinclair-Stoddart creeks Sheep Survey** Volume II, section 3.9; **Ungulate Pellet Counts and Browse Plots** Volume II, section 3.6; **Ungulate Roadside Surveys** Volume II, section 3.7; **Winter Tracking Transects** Volume II, section 3.10.

Do you wish to know about wildlife habitat and its distribution?

You will find that the **Ecosite**, the basic unit of the Ecological Land Classification, describes wildlife habitat very well. Each Ecosite has a characteristic pattern of landform, vegetation and microclimate, so reading the **Ecosite Accounts** in Volume I, or the abbreviated description in the **Map Legend**, is well worth the effort.

Wildlife habitat is discussed in general terms in each of the species accounts. However, much of the habitat data are incorporated in the various discussions of Ecosites.

Thus, for example, if you wish to know what types of habitat are present in a given area, and what their importance may be to wildlife (this sort of information is frequently needed in EARP reviews of proposed developments), you should proceed as follows:

1. Review the appropriate map in the **Map Supplement** that accompanies Volume I. Locate your area of interest on the map and list the Ecosite names that are indicated.
2. Read the **Master Legend** that accompanies the **Map Supplement**, or read the Ecosite accounts in Volume I. You now have a description of the habitats in the area. Through the CANSIS computer facility you can also find out how extensive these habitats are and thus get an idea of their relative rarity.

3. Wildlife data for each Ecosite are found in two places. The first is at the right side of the **Master Legend** where the Wildlife Legend provides a table of the relative importance of each Ecosite to selected wildlife species and a list of which breeding bird communities and small mammal associations occur there. The second is the Ecosite account section of Volume I. There the importance of the Ecosites to wildlife is discussed in somewhat more detail.

Following these steps will give you a good base from which to proceed with your assessment of habitat and habitat values in a certain area. However, you should be aware at all times that these data are based on sampling over a wide area and are averaged to provide generalizations valid at our 1:50,000 scale. **No site-specific questions can be answered solely by the information in this report.** A visit to the site is always mandatory since, for example, a generalization about sheep use of the DG3 Ecosite may be valid only in the Stoddart Creek watershed and not in the Kootenay watershed. There may be a coyote den, hawk nest, mineral lick or other important wildlife feature at a site that cannot be anticipated through this report.

All readers may be interested in the **Methods** (section 2) to see the means by which the above information was gathered. The **Results** (section 3) indicate the number of samples we collected and some of the highlights of the sampling. Plot and transect data and all wildlife observations are stored on the Canadian Soil Information System (CANSIS) computer in Ottawa and are accessible through Parks Canada computers in Western Regional Office and most park administrative offices.

Recommendations are presented in many of the species accounts (under Management), in the Ecosite accounts, and in the **Management Considerations** section (section 5).

1.2 THE STUDY AREA

The following description of the location and physiography of Kootenay National Park (KNP) is summarized from the detailed account in Volume I (Walker *et al.* 1984).

KNP occupies 1406 km^2 in the Rocky Mountains of southeastern B.C. (Figure 1.1). It is the southwesternmost of the four contiguous Rocky Mountain National Parks: KNP, Yoho National Park (YNP),Banff National Park (BNP) and Jasper National Park (JNP). It shares boundaries with YNP to the north, BNP to the northeast, and Mt. Assiniboine Provincial Park to the east. The Continental Divide forms the northeast boundary with BNP.

KNP touches four physiographic units that reflect geologic subdivisions: the Continental Ranges, divided into Main Ranges, with eastern and western sectors, and Western Ranges and to the southwest the Southern Rocky Mountain Trench. The eastern sector of the Main Ranges includes the Bow and Ball ranges along the Continental Divide in northeastern KNP. Here, Precambrian and Cambrian limestones and quartzites have been carved into broad massifs with castellated peaks. The highest elevations in KNP are in this area. The western Main Ranges stretch from Tokumm, Haffner and Verdant creeks to the Kootenay River. Except for the Vermilion and Mitchell ranges, most of the western Main ranges topography is less craggy than in the eastern sector. The topography of the Vermilion and Mitchell ranges resembles the eastern sector and is characterized by limestone cliffs, narrow ridges and castellate peaks.

The Western Ranges subdivision is similar to the western Main Range and includes the Brisco and Stanford ranges which are characterized by complex geologic structures, unique to the Canadian Rockies. Southwestern KNP touches on the Southern Rocky Mountain Trench. Its eastern wall forming the western limit of the Rocky Mountains

KNP occurs in the Columbia Basin. Most of the park drains via the upper Kootenay Major Watershed. An area in the northwest bordering YNP is part of the Kicking Horse River Major Watershed and the southwestern portion drains via the Columbia River Major Watershed.

Some nine watershed units and two subunits are recognized in KNP and are used in this report as natural regional subdivisions when discussing wildlife distributions and patterns of seasonal range and habitat use. These watershed units are also used in recording wildlife observaions on the Mountain Parks Wildlife Observation forms (MPI6). The boundaries of these watersheds are shown in Figure 1.2. A detailed description of drainage systems in KNP is presented in Volume I (Walker *et al.* 1984).

KNP has a continental macroclimate characterized by brief, cool summers and long, snowy winters. Owing to the predominant northwest-southeast orientation of mountain ranges and valleys which is nearly perpendicular to the prevailing westerly winds, there is a strong east-west gradient of temperature and precipitation. Areas west of the Continental Divide at similar elevations are moister than areas to the east. The east-west gradient in temperature is less distinct. Although KNP is milder than BNP when temperature extremes are compared, it is cooler based on mean temperatures.

The moister and possibly milder climate of KNP compared to areas east of the Divide is reflected in the vegetation. The Engelmann spruce-subalpine fir/false azalea (C14) and lodgepole pine/false azalea/grouseberry (C20) vegetation types are widespread in the Lower Subalpine of KNP whereas their distribution is restricted mainly to northerly and easterly aspects in western BNP.

The exception to the east-west moisture gradient occurs in the southwestern portion of KNP adjacent the Southern Rocky Mountain Trench. This area contains comparatively dry soil and vegetation including natural, semi-arid grassland. Precipitation in this area, especially in winter, decreases and temperatures increase up-valley.

In addition to the east-west variation in climate in KNP there are marked differences in climate from low to high elevations which are reflected by differences in vegetation physiognomy. Based on these differences the ecological land classification recognizes three Ecoregions: Montane, Subalpine with Lower and Upper portions and Alpine (Figure 1.3)

Figure 1.1. Location of Kootenay National Park, B.C..

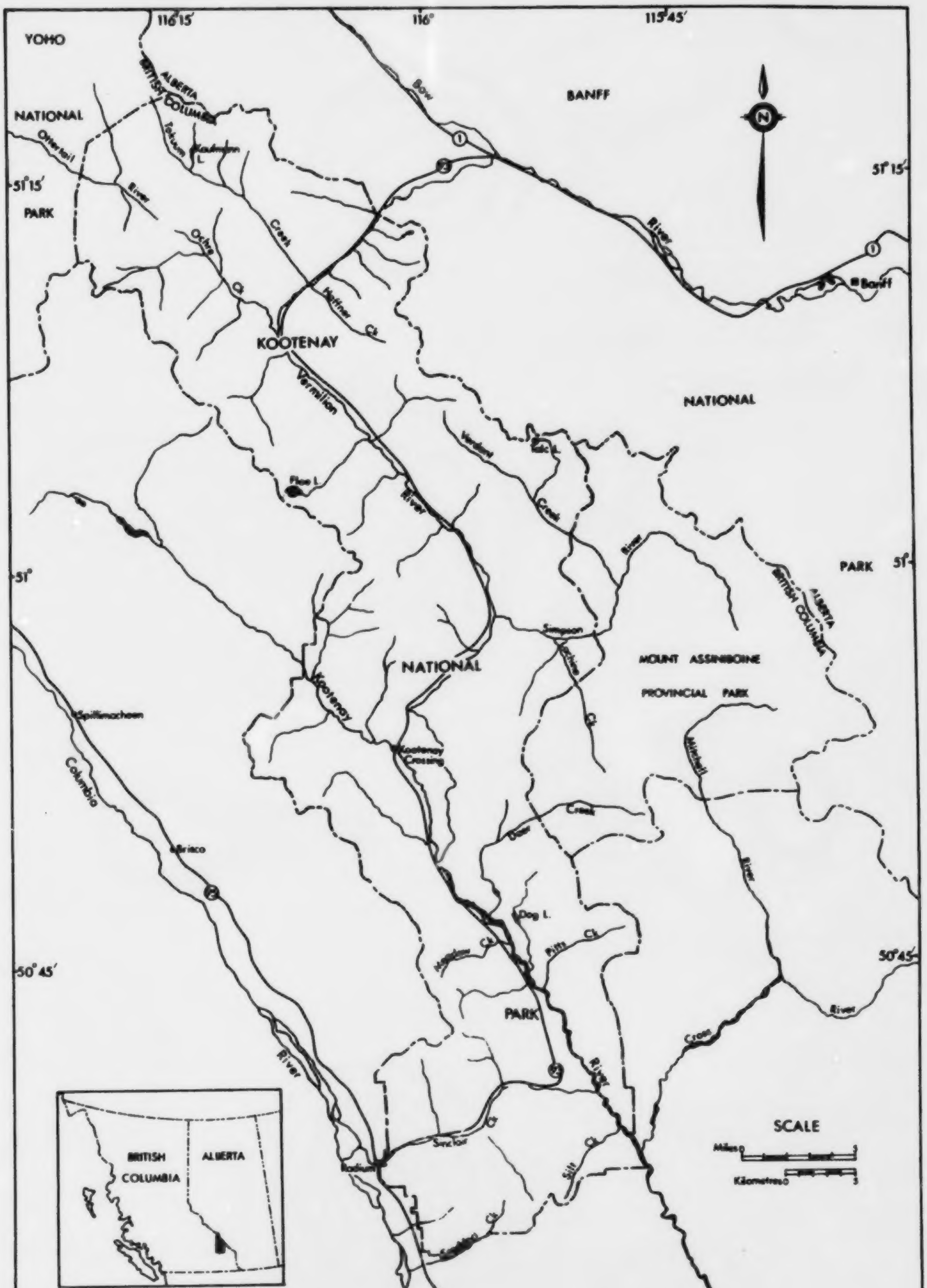

116°15′
116°
115°45′
YOHO
NATIONAL
PARK
51°15′
ALBERTA
BRITISH COLUMBIA
Ottertail
River
Tokumm
Kaufmann L.
Creek
Ochre
Ck.
Haffner
Ck.
Bow
River
Banff
BANFF
NATIONAL
PARK
KOOTENAY
Vermilion
River
Floe L.
Verdant
Creek
51°
Simpson
River
MOUNT ASSINIBOINE
PROVINCIAL PARK
NATIONAL
Kootenay
Kootenay Crossing
Spillimacheen
Columbia
Brisco
Mitchell
River
Daer
Creek
Dog L.
Pitts
Ck.
50°45′
PARK
Cross
River
Sinclair
Ck.
Radium
Ck.
Invermere
50°30′
SCALE
Miles 0 3
Kilometres 0 3
BRITISH COLUMBIA
ALBERTA

Figure 1.2. Watershed boundaries in Kootenay National Park.

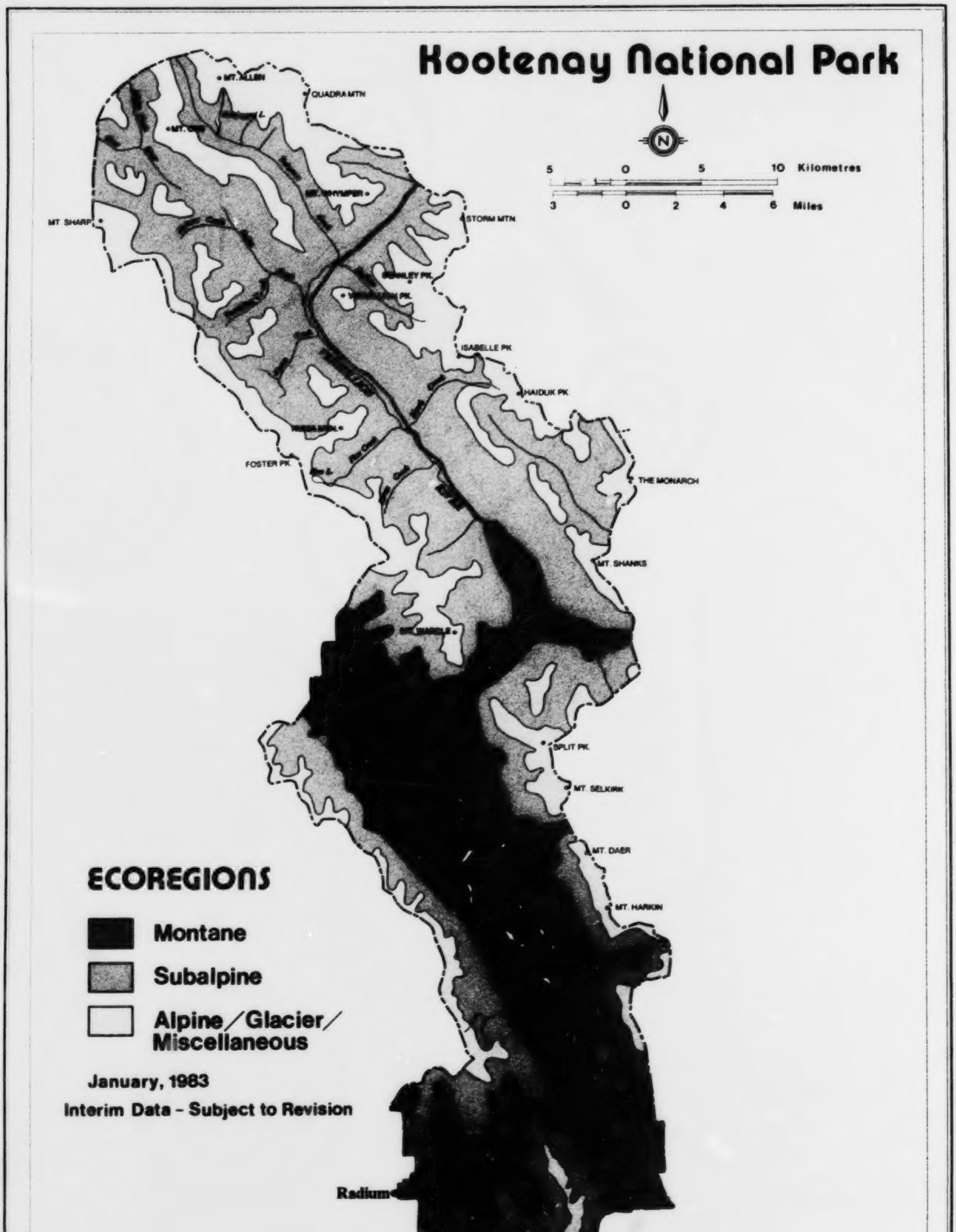
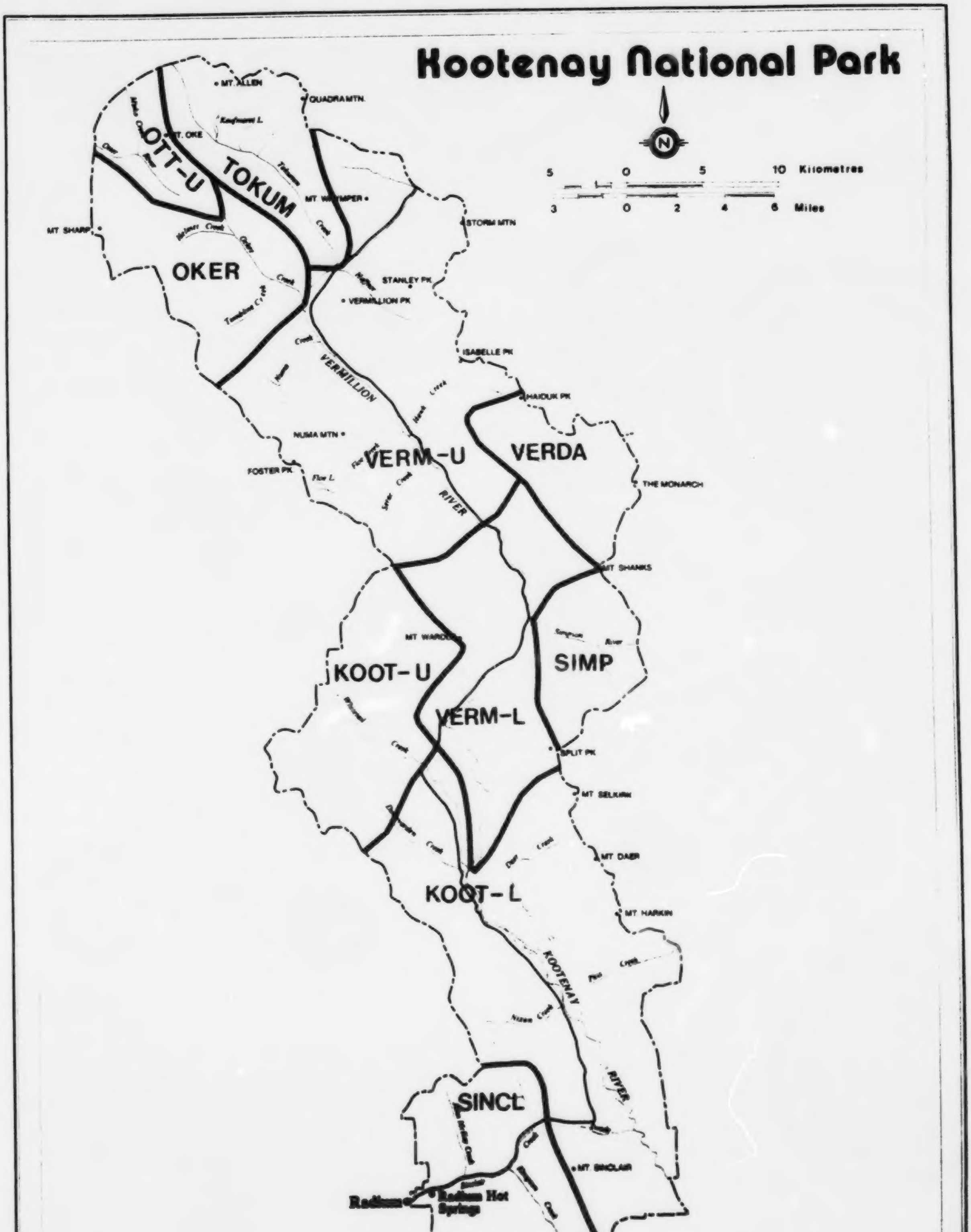

Kootenay National Park
N
5
0
5
10
Kilometres
3
0
2
4
6
Miles
MT. ALLEN
QUADRA MTN
MT. WHYMPER
STORM MTN
MT SHARP
ISABELLE PK
HAIDUK PK
FOSTER PK
THE MONARCH
MT. SHANKS
MT. MARBLE
SPLIT PK
MT. SELKIRK
MT. DAER
MT. HARKIN
Radium
ECOREGIONS
Montane
Subalpine
Alpine/Glacier/Miscellaneous
January, 1983
Interim Data - Subject to Revision

Figure 1.3. Ecoregions in Kootenay National Park.


Kootenay National Park
N
5 0 5 10 Kilometres
3 0 2 4 6 Miles
MT. ALLEN
QUADRA MTN.
MT. OKE
OTT-U
TOKUM
MT WHYMPER
MT SHARP
STORM MTN
OKER
STANLEY PK
VERMILLION PK
ISABELLE PK
VERMILLION
HAIDUK PK
NUMA MTN
VERM-U
VERDA
FOSTER PK
Floe L.
RIVER
THE MONARCH
MT SHANKS
MT WARDLE
Simpson River
KOOT-U
SIMP
VERM-L
SPLIT PK
MT SELKIRK
MT DAER
KOOT-L
MT HARKIN
KOOTENAY
RIVER
SINCL
MT SINCLAIR
Radium
Radium Hot Springs
STODD

The **Montane Ecoregion** is limited to the lowest elevations in KNP adjacent the Columbia valley (<1850 m.) and along the Kootenay (<1800 m), lower Vermilion and Simpson rivers (<1500 m.). Climatically, it is the warmest and driest Ecoregion, particularly in the southwest. Precipitation is low (300 to 600 mm) with peaks in mid-summer and mid-winter. Mean annual snowfall is 30-45% of total precipitation. Southern KNP has the lowest frequency of precipitation in the four contiguous mountain parks yet precipitation patterns suggest that the Montane of KNP is much less frequently snow-free in winter than the Montane of BNP and JNP. Vegetation reflects the comparatively drier climate than at higher elevations with lodgepole pine, mixedwood and Douglas fir forests and dry grasslands (restricted to the southwest). Extensive wetland complexes have developed along floodplains and are characterized by a mosaic of mixed and white spruce forests, spruce and willow fens and sedge meadows.

The **Subalpine Ecoregion**(from 1500-1900 m to 2300 m.) is the most extensive Ecoregion in the park. Precipitation is higher and temperatures cooler than in the Montane. Winter snow accumulation is greater and lasts longer.

The Lower Subalpine portion is characterized by extensive Engelmann spruce-subalpine fir closed forests except where fires in the last 150 years have resulted in lodgepole pine forests. On steep colluvial slopes frequent avalanching maintains open shrub and herb meadow communities. Climatically this region is milder than the upper Ecoregion with less precipitation, particularly in winter. However, snow accumulation is high enough to limit winter use by ungulates except moose.

The Upper Subalpine portion is characterized by steep slopes with open-canopied forests of Engelmann spruce-subalpine fir, subalpine larch -subalpine fir or of mixed conifers and avalanche shrub and herb meadows. Timberline is the upper limit of this Ecoregion. Snow accumulation is heavy and winters too severe for ungulates except on steep, wind-blown slopes and ridge crests. The area provides productive summer habitats for many species of wildlife.

The **Alpine Ecoregion**(>2300 m.) is higher, colder and receives heavier precipitation than any other Ecoregion. Tree growth is prevented by long, cold winters, short, cool summers and high winds. Vegetation is characterized by a mosaic of low shrub and herb communities.

Within each of these Ecoregions there is a variety of landforms, soils and vegetation that create a diverse habitat mosaic. Generalizations about wildlife distribution within any single Ecoregion are confounded by the variability of habitats within the Ecoregion. Volume I describes this variability and classifies the park with regard to recurring patterns of landform, soils and vegetation within each Ecoregion. This classification is the basis of discussions of wildlife habitat in subsequent sections of this volume.

1.3 HISTORICAL PERSPECTIVES OF MAN AND WILDLIFE IN KOOTENAY

EARLY HISTORY

The Kootenay Indians, who originally lived on the eastern slopes of the Rocky Mountains and were driven west by the Blackfoot in the late 1700's (Jenness 1963), were very familiar with the area of the Vermilion and upper Kootenay valleys. They obtained ochre from the Paint Pots in the upper Vermilion valley and made frequent use of the hot springs in Sinclair Canyon. These two areas, as well as several others along the Kootenay and Vermilion rivers, have been recorded as historic sites by Mitchell and Choquette (1973).

Regular crossings of the Rockies were made by the Kootenay Indians to hunt buffalo on the plains and to contact trading posts on the upper North Saskatchewan River. The Blackfoot and other tribes inhabiting the east slopes of the Rockies often travelled west, occaisionally to trade, but most often to raid the Kootenay and Salish indians in the upper Kootenay and upper Columbia valleys.

The Kootenay valley was a major north-south travel corridor for early aboriginal peoples and the east-west links via Whiteman Pass, Simpson Pass and Vermilion Pass were well known to these travellers. However, these passes were largely unknown to early white travellers until the 1840's. From the time of its discouvery in 1811 by David Thompson until the 1850's, the Athabasca -Pass was the principal route used by white travellers from the Canadian Plains to the interior of British Columbia.

Although David Thompson was the first white man to visit the Lake Windermere area of the upper Columbia valley in 1807, the first white man to travel through the Vermilion and Kootenay valleys was Sir George Simpson. In 1841 Simpson explored a route from the prairies to the Columbia River travelling via the Bow valley, across into the Vermilion and Kootenay valleys via Simpson Pass and into the Columbia over Sinclair Pass. James Sinclair, an agent of Simpson's Hudson's Bay Co., later followed a similar route to the Columbia on his way to Walla Walla, Washington with 23 families from Fort Garry.

In August, 1858 James Hector of the Palliser Expedition became the first white man to travel over Vermilion Pass. He followed the Vermilion River to its confluence with the Kootenay River, up the Kootenay and crossed the Great Divide via the Kicking Horse Pass. Hector noted of Vermilion Pass that it was the most favourable and inexpensive route for wheeled vehicles of the passes he had traversed.

Access to the Windermere area during early settlement was via Cranbrook or Golden. However, by the turn of the century settlers in the area felt a faster, more direct route to Banff and Calgary was required. In 1905, R. Randolph Bruce of Windermere approached the British Columbia premier with a proposal to build a road from Banff to the Columbia valley via the Vermilion and Kootenay valleys using Vermilion Pass which had been sited by Hector some 47 years previous as the best route for the construction of a road. Negotiations between the B.C. government, the C.P.R. and eventually the Government of Canada led to construction of the Banff-Windermere Road and ultimately the formation of Kootenay National Park.

ESTABLISHMENT OF KOOTENAY NATIONAL PARK

Construction of the Banff-Windermere Road, the first road to cross the central Canadian Rockies, was begun by the province of British Columbia in 1911. A shortage of funds which terminated construction after 23 km, prompted the proposal that the National Parks Branch complete the construction in return for lands within eight kilometres on each side of the road. The Banff-Windermere Road Agreement between the governments of Canada and British Columbia was signed in March 1919 and the all-weather gravel road from Eisenhower Junction to Radium was completed in 1923. In April 1920 the 1520 km^2 area surrounding the route was proclaimed a National Park.

The establishment of the park and provision of an all-weather road encouraged tourist and commercial traffic. Private commercial facilities were first developed around the Hot Springs in 1912 and expropriated by the park in 1922. The Radium Hot Springs Lodge was built by the Canadian Pacific Railway Company in 1928 and developed into a modern three-storey hotel in 1965. Bungalow camps in the area were developed in 1931, 1948 and 1954. Several other bungalow camps appeared along the Banff-Windermere route in the early years. Included were Marble Canyon Bungalow Camp and Vermilion Lodge in 1923, as well as cabin developments at Kootenay Crossing and Crook's Meadow in the 1950's. The only remaining commercial facility along the route is at Vermilion Crossing.

Upgrading of the road began in 1947 and the entire route was paved by 1952. A second upgrading to Trans-Canada Highway standards including construction of the Iron Gates Tunnel and the difficult section through Sinclair Canyon was completed by 1965.

The first permanent administrative headquarters including a superintendent's residence and staff quarters were built on the slope above the Hot Springs pool between 1923 and 1929. New administrative buildings overlooking the Columbia valley and a maintenance compound at John McKay Creek were constucted in the early 1960's. Several small campgrounds and picnic sites were developed after opening of the road in 1923. Many of the picnic sites exist today, and modern campgrounds were developed at Marble Canyon, McLeod Meadows and above the Columbia valley during the 1960's.

The first priority of the warden service, established shortly after the park's inception in 1920, was to construct fire roads and lookout towers. Some 320 km of fire roads and two fire towers, one on Mt. Daer and one on Mt. Shanks were constucted prior to 1961. Several backcountry patrol cabins as well as permanent warden stations at Marble Canyon and Kootenay Crossing are still maintained.

The original boundaries of the park were surveyed in 1926, however in 1928 an amendment by Order in Council saw the transfer back to B.C. of the portion of the Banff-Windermere Highway from the West Gate to Radium Junction. A further adjustment of the boundary was proposed in 1961 which included the incorporation of two large lots in the Radium Hot Springs area and some 23 km^2 in the Simpson Pass area into the park in exchange for park lands in the Mt. Berland and Dry Gulch Creek areas. The proposal has since been amended to substitute the area in Simpson Pass for some 415 ha. in the Stoddart Creek area beyond the present south boundary. This exchange is currently under consideration by Parliament and the B.C. Legislature.

WILDLIFE MANAGEMENT

Early wildlife management in KNP, as in the other mountain national parks, was that of selected protection. Consistent with the state of wildlife conservation of the time, predators were excluded from the list of species to be protected by parks. The role of predators in natural ecosystems was not appreciated by early managers and as predators killed many of the wildlife species which tourists wanted to see, they were considered undesirable.

The burgeoning ungulate populations in KNP during the 1930's and 1940's as a result of abundant fire-successional habitats following fires in 1917 and 1926, led to increases in predator populations further fueling the anti-predator sentiments. In March 1933, Ottawa distributed a "Policy Governing Predatory Animal Control in the National Parks of Canada" which listed wolves, coyotes, wolverine, cougar, Goshawk, Cooper's Hawk, Great Horned Owl, Crow and Magpie as species to be shot on sight (Holroyd and Van Tighem 1983) .

Predator control extended into the 1950's when the fear of rabies intensified control efforts and included the use of poison to eliminate canids in the park. Not until 1959, after recommendations by D. Flook of the Canadian Wildlife Service, that predator control for wildlife management purposes was no longer valid, was the era of predator control officially ended. Predators could still be destroyed if they posed a threat to humans or property, but game protection was no longer a valid reason.

Bears have been the focus of considerable management since the park's inception. The proliferation of bungalow camps, picnic sites and Alternate Service Workers (ASW) camps in the 1940's and 1950's led to considerable conflicts with bears and garbage. Earliest bear management was mostly by shooting and not until the 1960's did more effective garbage management and removal of many areas of human habitation begin to supplant the practice of destroying or relocating bears.

Much of the recent effort to study bear ecology in the mountain parks has centred on grizzlies, although black bears have been the focus of much more intensive management. Black bears continue to be relocated or destroyed each year in KNP, albeit at a much reduced level from former years, and will probably continue to be until their ecology in the mountain environment is better understood.

WILDLIFE RESEARCH

The need to catalogue park resources, including wildlife, was recognized as early as 1938, when month-end wildlife reports were initiated. These included estimates of large mammal numbers and status in each of the three warden districts and notes on management activities and weather conditions. In 1952 a monthly diary summary sheet was instituted with the following instructions regarding wildlife observations:

> ".....list the total number of each species seen by you in your district during the month. This is the total of your daily observations of all wildlife seen, even though you may see the same animal day after day. Fill out the wildlife cards for recording details of groups, herds, tracks, localities, etc. according to the instructions which you already have. Use wildlife cards in every instance for recording animals found dead, and animals destroyed by you."

Because these monthly summaries include obvious duplication of sightings they are of limited value for determining relative wildlife population sizes. Nevertheless they do demonstrate that wildlife observations were encouraged and more attention was being paid to standardized formats.

The cards referred to above were those devised by A.W.F. Banfield and instituted in KNP in 1951. Although they represented a first effort at standardizing wildlife observations in the parks, they did generate some controversy among the wardens as illustrated by the comment of Warden Gardner of GNP: "if it could be so arranged I would like to see Wildlife Officer Banfield pay a visit and become conversant with the particular wildlife problems existent." Nevertheless these cards now represent a valuable documentation of wildlife distribution and abundance in the National Parks.

The data from these cards were summarized by Canadian Wildlife Service biologists in annual reports from 1952 to 1957 (Banfield 1952, Tener 1953, Ward 1954,1956 and Francis 1957). Francis (1958) summarized warden wildlife observation cards of carnivores in the mountain parks from 1951 to 1958.

The original cards were replaced by the McBee Punch Card in the 1960's and since 1978 wildlife observations have been coded onto a computer format card (MPI6) for input to the CANSIS computer system in Ottawa. As part of the wildlife inventory in KNP the 5727 wildlife cards prior to 1978 were computer coded and input into the CANSIS system.

The earliest published descriptions of the ecology and wildlife species in KNP were compiled by Cowan (1943) and Munro and Cowan (1944). These comprehensive reports, discussing the physiography, life zones, wildlife habitats and providing annotated lists of 79 species of birds (69 observed by the authors) and 44 species of mammals, were based on three weeks of field work by J.A. Munro and one week by I. McTaggart Cowan during June 1943. The authors also examined park records and talked to park wardens and local residents. While these reports are benchmarks for many species of birds and most mammals occurring in KNP, they contain little quantitative information on wildlife populations.

A checklist of the mammals of KNP was compiled by Seel (1965a) based on specimen records and the work of Munro and Cowan (1944).

From his field observations between 1962 and 1964, Holroyd (1967) described the life history, herd size and composition and seasonal distribution of mountain goats on Mt. Wardle. Behavioural studies of goats in this same population were conducted in 1967 and 1968 by DeBock (1970).

Bighorn sheep were intensively studied in the mountain national parks including KNP between 1966 and 1972. Stelfox (1971) gave an historical account of sheep populations and their fluctuations in the Canadian Rockies for the period 1800 to 1970. He investigated the status of sheep and their range in KNP during the pneumonia -lungworm related die-off in fall 1966 (Stelfox 1966) and presented a detailed account of the parasites and diseases of bighorns in Waterton, Banff, Jasper and Kootenay national parks from 1966 to 1972 (Stelfox 1976a). Stelfox (1978) described the seasonal distribution, abundance and range use of bighorns in the mountain parks including KNP between 1966 and 1972. From 1972 to 1978 the seasonal distribution of elk was investigated using colour banding and radio telemetry by the Warden Service and the B.C. Fish and Wildlife Branch (Gibbons and Baker 1976, Gibbons 1978a). Little specific information, other than the previously noted general historic references and the wildlife observation cards, exists for other large mammals in the park. Mortality records of wildlife along the Banff-Windermere Highway were compiled by Sheehan and Peers (1979), Sheehan (1982) and Damas and Smith (1982).

Small mammals (Shank 1971, Reid 1972, Fitzmartyn 1973, Guy 1975) and birds (Edwards 1972, Scott 1973, O'Keefe 1975), were studied intensively as part of the Vermilion Pass burn studies from 1971 to 1976. The burn studies are summarized by Harris (1976).

A checklist of birds in KNP was prepared by Seel (1965). A comprehensive review of park avifaunal records and an annotated checklist were compiled by Van Tighem (1977).

In 1981 field work began for the Ecological Land Classification of KNP of which the Wildlife Inventory was a major component. While detailed understanding of the wildlife dynamics in KNP will only come from detailed, species-specific research, this project the last in a series of resource inventories in the mountain national parks - constitutes the first systematic inventory of wildlife and their habitats in KNP.

This final report, in conjunction with Volume I (Achuff *et al.* eds. 1984) and the Map Supplement, represents the latest stage in the evolution of wildlife inventory in the western National Parks. Future needs, as yet unanticipated, will no doubt lead to further evolution in the theory and practice of park wildlife inventories, and to further refinements of our knowledge about wildlife in these parks.

2. METHODS

2.1. SAMPLING RATIONALE

Methods were chosen to collect data on the seasonal abundance, distribution and habitat characteristics of all species of mammals, birds, reptiles and amphibians that occur in KNP (Tables 2.1 and 2.2). The broad scope of the inventory and the large area necessitated a variety of sampling methods. Some were directed specifically at relating wildlife abundance to the Ecological Land Classification. Others were used to survey the seasonal movements of selected wildlife, to determine actual densities of some species and to locate less common species. In addition to these primary methods, described below in detail, the wildlife inventory staff lived near Radium Hot Springs on a year-round basis and became familiar with the park and with long-time park residents.

There were three major approaches to gathering wildlife data as outlined below.

2.1.1. SYSTEMATIC SAMPLING OF ECOSITES

A major objective of the inventory was to assess the importance of Ecosites to all wildlife species. Given the large area to be inventoried and the probability that wildlife use would vary even for the same Ecosite in different parts of the park, it was necessary to obtain several samples of each Ecosite throughout the park. The sample techniques used were therefore fast, simple, yet quantitative.

The major constraints on developing these techniques were:

- Each must sample a small enough area that it will fit entirely within the boundaries of one mapped polygon and one vegetation type The maximum area sampled, therefore, was 500 m. x 500 m.
- each must require a limited amount of time, effort and equipment, to allow a small staff to sample numerous sites over a wide area and in very rugged terrain.
- each must be standardized, easily taught to new staff, and based on the best techniques in the published literature at the time the project was initiated.
- each must be quantitative in order to provide indices of abundance that would be directly comparable from one Ecosite to the others.
- where possible, techniques had to be compatible with soil and vegetation sampling procedures to allow wildlife inventory staff to work in integrated field teams.

The techniques which fulfilled these requirements and sampled all the major wildlife species groups were pellet group counts, browse use transects, track count transects, circular bird census plots and snap traplines (Table 2.1). In addition, random observations by park and inventory staff, in many cases, could be

Table 2.1. The matrix of species groups sampled by each technique, and total sample sizes.

Species group: *Technique:*	*UNGULATES*	*CARNIVORES*	*HARES*	*SQUIRRELS*	*SMALL MAMMALS*	*BIRDS - breeding*	*BIRDS - migrant*	*BIRDS - wintering*	*AMPHIBIANS*	*REPTILES*	*BATS*	*BEAVERS, MUSKRATS*	
Ungulate survey	•												3 routes
Track count transect	•	•	•					•					315.4 km/day
Pellet count transects	•		•										928
Forage use plots	•		•										4240
Snap trapline					•								10,000 trap-nights
Live-trap plot					•								2
Bat survey											•		?? nights
Circular bird plot				•		•							605
Owl Survey						•			•				1 route
Breeding bird census plot				•		•							2
Migration survey							•	•					1 routes
Christmas bird count								•					1 area
Pond survey						•	•		•			•	13 sites
River survey						•	•		•			•	1 river; 1 trip
Random observation	•	•	•	•	•	•	•	•	•	•	•	•	
Data review	•	•	•	•	•	•	•	•	•	•	•	•	

related directly to Ecosite importance.

The approach to selecting actual sample locations varied. Pellet group and browse use transects were conducted almost exclusively in conjunction with soil and vegetation sampling, therefore site selection was based on criteria for soil and vegetation sampling. The selection of sample locations for other methods was more subjective. An attempt was made to sample as many Ecosite/vegetation type combinations as possible in each season and watershed. Ecosites were selected from the 1:66,000 mapped air photos provided by the land inventory crew and chosen for sampling based on vegetation sample data, accessibility (primarily in winter), size of the polygon, and proximity to other suitable Ecosites. Complete coverage of all Ecosites in all drainages was not possible due to rugged terrain, dense, dead-fall laden forests and, in winter, extreme avalanche hazards in many side valleys.

Camps were located at warden patrol cabins where possible or in tent camps near complexes of Ecosites where cabins were not available. During summer of 1981 and 1982 field crews were composed of pedologists, botanists and wildlife inventory staff, while during the two winters (1982 and 1983) and summer of 1983 wildlife inventory staff worked alone. From each camp, field crews of two to four persons sampled as many different Ecosites as possible in 2 or 3 days, before moving to another location.

Table 2.2. The matrix of wildlife information provided by each technique.

Wildlife information:	STATUS and DISTRIBUTION	ECOSITE IMPORTANCE	SEASONAL HABITAT USE	SEASONAL MIGRATIONS	POPULATION STRUCTURE; PRODUCTIVITY	MORTALITY	MANAGEMENT	PREDATION	ECOLOGY	FOOD HABITS
Technique:										
Mountain goat survey	•	•	•	•	•				•	
Bighorn sheep survey	•		•	•	•				•	
Roadside elk survey	•	•	•	•	•				•	
Track count transect	•	•	•						•	
Pellet group/forage plot	•	•	•						•	•
Snap trapline	•	•			•					
Live-trap plot					•					
Bat survey	•			•						
Circular bird plot	•	•	•							
Owl survey	•									
Breeding bird census plot					•					
Migration survey	•		•	•					•	
Christmas bird count	•		•	•						
Pond survey	•		•	•	•				•	
River survey	•		•	•	•				•	
Random observation	•	•	•	•	•	•	•	•	•	•
Literature review	•		•	•	•	•	•	•	•	•

*Ecosite importance is assessed to some extent by all methods but is directly assessed by those indicated above

The main criteria for locating sample plots was that they had to fall entirely within the boundaries of one Ecosite and one vegetation type. In some complex Ecosites such as avalanche slopes or alluvial areas, where vegetation was heterogeneous, this was not possible and the sample was considered to have been collected in the most prevalent vegetation type at that site.

The primary use of the quantitative data derived from these Ecosite-specific methods was to assign importance values to each Ecosite, based on measured use by wildlife. Importance values were used in the Ecosite accounts (Volume I) and Master Legend (Map Supplement). The data were also incorporated into the appropriate Species accounts in this Volume (Section 4).

2.1.2. WILDLIFE SAMPLING INDEPENDENT OF ECOSITES

Although ecological land classification lends itself well to the interpretation of wildlife use by most animal species, there are important aspects of the ecology of many species that cannot be assessed by the direct Ecosite sampling described above. These aspects involve such things as seasonal changes in distribution and habitat use, particularly by ungulates; critical habitats related to life cycle events such as breeding, nesting and denning; bird migration; and population characteristics of some species (Table 2.2).

To assess these aspects of wildlife ecology it was necessary to devise sampling methods that were somewhat less suited to the primary goal of assessing wildlife use of and abundance on Ecosites. Such methods, described below in greater detail, included roadside surveys of mountain goats, bird migration surveys, owl surveys, bat surveys, pond surveys and live trapping. Although all data collected by these methods were referenced to Ecosite and vegetation type whenever possible, no attempt was made to systematically sample all Ecosites by any one of these methods.

2.1.3. REVIEW OF LITERATURE, DATA BANKS AND PARK FILES

It was necessary to assess the amount of change to which wildlife populations had been subjected during recorded history in order to view their present status and distribution in the context of on-going processes. The history of landscape change, park management and population increases and declines all influence the present wildlife picture and potential management options.

It was also necessary to review published literature to relate park wildlife populations to those in other areas, to gather species-specific information on productivity, food habits, natural history and mortality, and to review and assess various approaches to management.

2.2. SAMPLING PROCEDURES

2.2.1. CIRCULAR BREEDING BIRD CENSUS PLOTS

To assess the relative density of territorial birds, as well as pikas and sciurids on Ecosites in KNP the wildlife inventory team used circular plots surveyed from single points, based on a modification of the variable circular-plot technique described by Reynolds, Scott and Nussbaum (1980). A number of refinements to this method were incorporated to take into account our specific needs and operational constraints, experience in Banff and Jasper (Holroyd and Van Tighem 1983), and recommendations from several of the authors in Ralph and Scott (1981).

The sampling season was between about 1 June and 15 July, and sampling of territorial birds was limited to between 1/2 hour before sunrise and 10:00 AM. The goal was to sample each Ecosite at least four times (Gates 1981) and preferably twice that many times.

The procedure was as follows:

Sampling transects were located on aerial photographs prior to going in the field. Transects were chosen to cross a variety of reasonably extensive, homogeneous habitats. Points were sampled along the transects at sites at least 200 m. apart from 1/2 hour before sunrise until 10:00 AM or until song activity was judged too low to be truly representative of bird density. Each plot had a radius of 100 m that enclosed no major changes in landform or vegetation cover.

At each sample plot the observer remained stationary one full minute before beginning to record wildlife activity. During this period the site description was recorded (Figure 2.1).

All wildlife seen or heard were recorded on a field sheet (Figure 2.2). The observer estimated the distance to each individual at the location where it was first seen or heard and plotted this on the field sheet. If the individual moved during the sampling period, an arrow was drawn to each new location. There were two five-minute intervals comprising one 10-minute sampling period. The observer used a different symbol to indicate sightings during the remaining five minutes.

Each circular plot was sampled only once. It was assumed that ten minutes allowed most of the territorial wildlife on the plot to be detected. We assumed that all samples on one Ecosite or vegetation type are equivalent and that several samples from different tracts of an Ecosite or vegetation type represent a multiple sample of one habitat.

Birds seen or calling outside the plot were recorded as random observations on the field sheet. All red squirrels, Columbian ground squirrels, pikas and marmots were recorded; thus this method sampled all vocal, territorial animals.

Data were analyzed by both the variable-circle method and a modification of the coefficient of detectability (CD) method (Emlen 1971, 1977).

2.2.2. BIRD MIGRATION SURVEYS

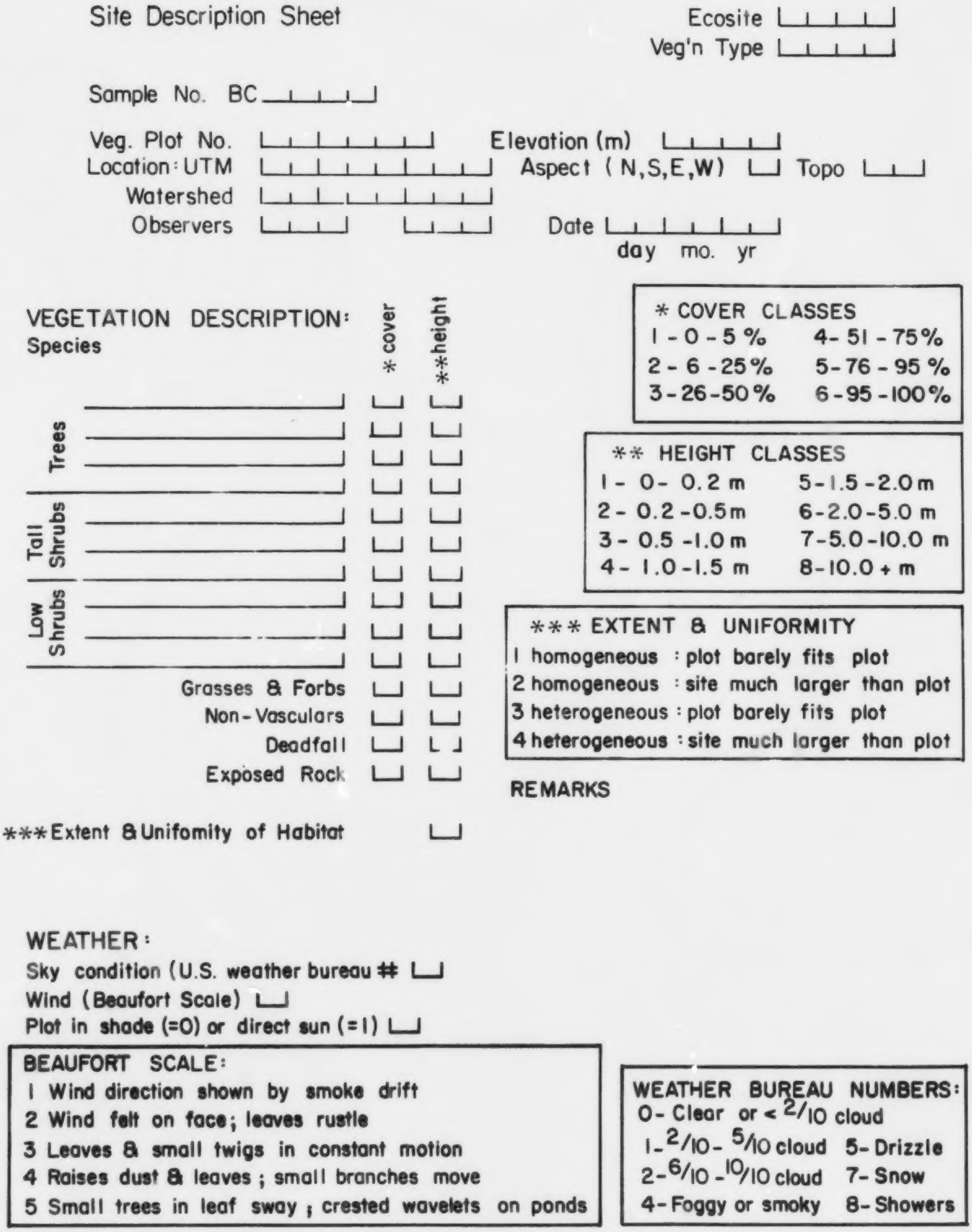
The methodology for the spring migration surveys is the same as the Breeding Bird Survey described by Erskine (1978). The surveys were conducted along Highway 93 in KNP from March to June 1982. Fifty stops were made at 0.8 km (0.5 mi) intervals or a distance of 40 km (25 mi), starting at the west gate and ending at the "airport meadows" in the Kootenay Valley. Surveys were initiated 1/2 hour before dawn and continued over a four hour period.

Two observers surveyed the route weekly, and observer variability was reduced by comparisons during annual training sessions. All individual birds seen or heard at each stop during the 3 minute period were counted.

2.2.3. BREEDING BIRD CENSUS PLOTS

To determine the density of breeding birds in several representative habitats in KNP as accurately as possible, the territories of singing male birds were mapped on two plots during June and July 1983. Sampling was conducted by the methods outlined by Hall (1964). Census plots were walked by two observers and the locations of singing males plotted on a sketch map of the plot. Arrows were used to indicate when birds moved to new perches or to indicate birds singing simultaneously with others. At the end of the field season

Figure 2.1. Site description form for circular bird census plots.



Site Description Sheet

Ecosite ☐☐☐☐
Veg'n Type ☐☐☐☐

Sample No. BC ☐☐☐☐

Veg. Plot No. ____ Elevation (m) ____
Location: UTM ____ Aspect (N,S,E,W) ☐ Topo ☐☐
Watershed ____
Observers ____ ____ Date ____ day mo. yr

VEGETATION DESCRIPTION:

	Species	* cover	** height
Trees		☐	☐
		☐	☐
		☐	☐
		☐	☐
Tall Shrubs		☐	☐
		☐	☐
		☐	☐
Low Shrubs		☐	☐
		☐	☐
		☐	☐
	Grasses & Forbs	☐	☐
	Non-Vasculars	☐	☐
	Deadfall	☐	☐
	Exposed Rock	☐	☐

***Extent & Unifomity of Habitat ☐

* COVER CLASSES	
1 - 0 - 5 %	4 - 51 - 75%
2 - 6 - 25%	5 - 76 - 95 %
3 - 26 - 50 %	6 - 95 - 100%

** HEIGHT CLASSES	
1 - 0 - 0.2 m	5 - 1.5 - 2.0 m
2 - 0.2 - 0.5 m	6 - 2.0 - 5.0 m
3 - 0.5 - 1.0 m	7 - 5.0 - 10.0 m
4 - 1.0 - 1.5 m	8 - 10.0 + m

*** EXTENT & UNIFORMITY
1 homogeneous : plot barely fits plot
2 homogeneous : site much larger than plot
3 heterogeneous : plot barely fits plot
4 heterogeneous : site much larger than plot

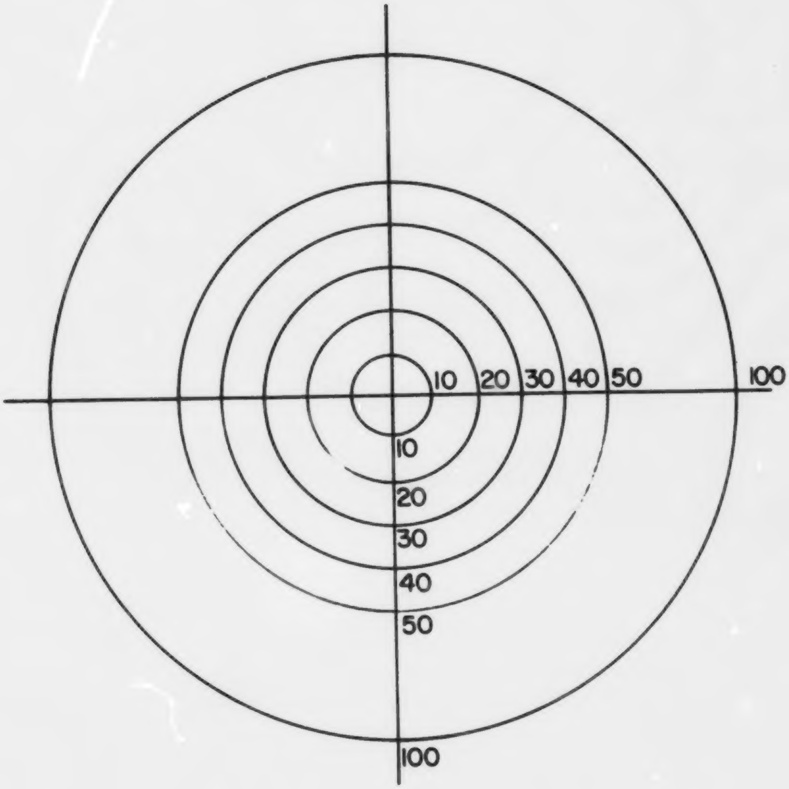
REMARKS

WEATHER:
Sky condition (U.S. weather bureau # ☐
Wind (Beaufort Scale) ☐
Plot in shade (=0) or direct sun (=1) ☐

BEAUFORT SCALE:
1 Wind direction shown by smoke drift
2 Wind felt on face; leaves rustle
3 Leaves & small twigs in constant motion
4 Raises dust & leaves ; small branches move
5 Small trees in leaf sway ; crested wavelets on ponds

WEATHER BUREAU NUMBERS:	
0 - Clear or < 2/10 cloud	
1 - 2/10 - 5/10 cloud	5 - Drizzle
2 - 6/10 - 10/10 cloud	7 - Snow
4 - Foggy or smoky	8 - Showers

Figure 2.2. Field data sheet for circular bird census plots.


10
20
30
40
50
100
10
20
30
40
50
100

SAMPLE NUMBER PC

OBSERVER

DATE

START TIME

○ -First 5 minutes S-song V-visual
● -Last 5 minutes A-alarm C-call F-flying past

composite maps were drawn of each census plot showing single-species distributions of singing males with clusters of sightings interpreted as single territories.

The plots were in:
a. Montane Mixed Forest (FR3; C44)
b. Montane Douglas fir Open Forest (WY2; O5)
Plot locations and descriptions are in Section 3.2.3 (below). They are presented in the format used by **American Birds**. Neither plot is permanently marked. Map co-ordinates are in the text and locations shown in Figures 3.11 and 3.12. Detailed results are in **American Birds** Jan.-Feb. 1984, vol 38.

2.2.4. OWL SURVEYS.

The KNP owl survey route followed Highway 93 from Sinclair Canyon to Kootenay Crossing, with stops every kilometre. Surveys in the Vermilion valley were not feasible due to the narrowness of the valley and excessive river noise. Fire roads were not surveyed since they were still snow-bound in April.

Surveys began after sunset and lasted about three hours. At each stop the observer listened for from one to five minutes depending on interference from background noise. Surveys were run weekly from early March until late May, 1982.

On each survey weather data (cloud cover, wind, precipitation) and the stage of the moon were recorded, along with habitat data where possible.

2.2.5. POND SURVEYS

Pond surveys were unstructured, periodic searches of water bodies for reptiles, amphibians, waterfowl and aquatic mammals.

Pond visits were initiated as soon as the spring thaw began in late April. The ponds were usually surveyed during the day and continued throughout the season into late summer.

The following information was recorded each time a species of amphibian was encountered: air and water temperatures, substrate type, time of day, numbers seen, and behaviour.

2.2.6. PELLET GROUP COUNTS AND BROWSE USE SURVEYS

Ungulate pellet group density and snowshoe hare pellet frequency were the major measures used to assess the relative importance of each Ecosite to these herbivores. It was assumed that ungulate pellet group densities and hare pellet frequencies would be highest on Ecosites where they spend the most time and that this reflects the relative importance of an Ecosite to a species. The importance of certain highly localized but seasonally critical ungulate ranges such as calving and rutting areas may be underestimated by pellet group density values. Additional methods were used to assess these types of ranges.

It was futher assumed, as most ungulates (particularly cervids) and snowshoe hares, use woody browse material for forage during the critical winter period, that an assesment of this use would provide an indication of seasonal range use and conditions as well as winter use of Ecosites.

Table 2.3. Criteria for rating the degree of hedging on browse plant species by ungulates (after Cole 1959).

Hedge class	*Notation*	*Description*
None to Light	A	Less than 50% of two-year-old wood having clipped ends; most of current year's growth extending from terminal buds of two-year wood
Moderate	B	50-75% of two-year-old wood clipped; most of current year's growth extending from lateral buds of two-year-old wood
Severe	C	Greater than 75% of two-year wood clipped; most of current year's growth is clumped with lateral and/or adventitious sprouts from two-year wood; normal growth form strongly altered
Decadent	D	Plant mostly dead; new growth all adventitious
Dead	E	Plant dead; no new growth

Table 2.4. Criteria for rating the degree of hare (after Pease *et al.* 1979) and microtine browsing.

Browse class	*Notation*	*Description*
Hare		
Girdled	1	Girdled
Severe	2	Terminal shoot clipped, 90% laterals clipped
Heavy	3	Terminal shoot clipped and/or 50-90% of laterals clipped
Moderate	4	Much barked and/or 10-50% of laterals clipped
Light	5	Slightly barked and/or <10% of laterals clipped
None	6	No clipping or barking (hare or microtine)
Microtine		
Heavy	7	Terminal shoot and/or 50-90% of laterals clipped
Moderate	8	Much barked and/or 10-50% laterals clipped
Light	9	slightly barked and/or <10% laterals clipped

Owing to the difference in sampling rationale between the Banff-Jasper and KNP wildlife inventories (see above) major changes to the pellet group counts and browse use survey methodologies were required. The time and manpower constraints associated with the team approach to field sampling required that the pellet count and browse assessment methodologies be streamlined.

The basic sample plot was designed around a 20x20 m. vegetation plot with a soil pit at the centre. The plot consisted of four parallel 2x50 m. transects spaced 20 m. apart; two transects on either side of the soil-vegetation plot. Ungulate pellet groups were counted along each of the four transects for a total sample area of 400 m^2. In addition, along each of the transects at five metre intervals a one square metre plot was searched for hare pellets. Hare pellets were recorded as either present (+) or absent (-) in a total sample area of 40 m^2.

Herbivore use of woody browse species was assessed by sampling one of each shrub species present in a 2.5 m. diameter plot. Browse plots were placed at five metre intervals along the two 50 m. transects nearest to the soil-vegetation plot. The individual plant of each shrub species present within the plot nearest to the plot centre was chosen for sampling. The information recorded for each shrub sampled included:

Height Class of shrub in 50 cm. increments and age category (seedling, young, mature (>1 cm basal diameter): Class 1: 0-50 cm., Class 2: 50-100 cm.; Class 3: 100-150 cm., Class 4: 150-200 cm., Class 5: 200 cm. + (Trottier and Hutchison 1980).
Percent ungulate browsing calculated from the ratio of the number of twigs browsed/total twigs.
Rating of the degree of hedging on plants by ungulates, based on the system of Cole (1959) (Table 2.3).
Degree of hare and/or microtine browsing (Table 2.4).

The methodology described was the end-product of an evolutionary process that involved testing of several techniques, therefore some of the earliest pellet and range samples employed a different sampling procedure: initially a 2 x 6 m. plot at the start of each 50 m. transect was searched for hare pellets and the total number of pellets was recorded; in two of the four 12 $m.^2$ plots all of the shrub species present were rated for ungulate, hare and/or microtine use according to the same criteria described above. This procedure not only proved too time consuming but too often was unrepresentative of the vegetation site as a whole. The methodology finally adopted gives a more representative sample of the vegetation type. Data collected with the old procedure were compiled to conform to the new procedure.

2.2.7. UNGULATE SURVEYS

The alignment of Highway 93, which bisects the park from north to south through the Vermilion and Kootenay valleys, afforded an excellent opportunity to monitor the seasonal distribution and the extent and seasonal pattern of use of the highway corridor by ungulates. The surveys provided information on the relative abundance of the various ungulate species and an indication of population structure from classified counts. This was especially useful for elk and white-tailed deer which make extensive use of the highway right-of-way at various times of the year.

Weekly surveys of the highway corridor were conducted along a 71 km route between the Settler's Road junction and Marble Canyon Warden Station from 11 May 1981 to 20 May 1982. Surveys from May through November were conducted in the evening, timed to official sunset times. However, comparison of results of November surveys with those done by the Warden Service indicated that early morning surveys obtained higher counts. Therefore, beginning in December, surveys were done in early morning commencing one-half hour before official sunrise. The exact location of all animals seen along the survey route was recorded and ungulates were classified as to sex, age, habitat (where observed) and adjacent habitat. The data were later transferred to Mountain Parks Wildlife Ground Survey Data Forms (GPI6).

2.2.8. MT. WARDLE GOAT SURVEY

The mountain goat population of Mt. Wardle is a highly visible feature of the fauna of KNP. This population is one of the few in the park for which a fairly detailed and lengthy record exists. Two major studies of this population were conducted by Holroyd (1967), who described the life history and status of this population between 1962 and 1964, and by DeBock (1970) who studied the social behaviour of these goats. The only systematic surveys of this population done since 1968 were several surveys in 1978 (Gibbons 1978), and no previous attempt has been made to assess seasonal habitat use. As part of the Ecological Land Classification, systematic surveys were undertaken to determine abundance, productivity, seasonal distribution and seasonal habitat use of mountain goats on Mt. Wardle.

The area under study included the southwest, south and southeast-facing slopes of Mt. Wardle, ranging in elevation from 1200 m. in the Montane Ecoregion on the valley floor to 2480 m. in the Alpine Ecoregion at the summit of the southern peak. The entire area is visible from the Highway 93 between Hector Gorge Viewpoint and Wardle Cr.

The wintering areas on Mt. Wardle include the south and southeast slopes between 1200 and 1900 m. (Figures 2.3, 2.4) (Holroyd 1967, DeBock 1970). These slopes are characterized by rugged rock outcrops, timbered ledges, cliffs and slide paths. The area was burned over in 1926 (Munro and Cowan 1944) to an elevation of 2100 m. (DeBock 1970). Fire, avalanching and meso-climatic features of slope, aspect, moisture and temperature have combined to create a diverse vegetation mosaic.

Summer ranges visible from Highway 93 include the southwest facing slope of Mt. Wardle. This aspect is somewhat less rugged than the winter range areas. It is characterized by open talus slopes and slide paths interspersed with steep alpine tundra on the upper sections while open rock bluffs and cliffs predominate on midslope areas (Figure 2.5). The remaining summer ranges are on the Vermilion Range north of Mt. Wardle and are not visible from the highway. Surveys of the southern slopes of Mt. Wardle were conducted approximately twice monthly or as weather conditions permitted from 26 July 1981 to 13 January 1983. Initially a series of five stops were established along Highway 93 between Hector Gorge viewpoint and Wardle Cr. picnic site. Goats were observed using 7x35 binoculars and a 20X spotting scope. Whenever possible the age/sex class of goats was recorded based on the criteria described by DeBock (1970). Black and White oblique photographs of the south facing slopes from each stop were used in plotting locations of goats during each survey. Experience during initial surveys showed that owing to the rugged nature of these slopes additional observation points were required to obtain complete coverage of the mountain side. Hence, three to four stops were used per oblique view. At the outset, surveys began between 0900 and 1000 h. in the morning, however variable starting times were tried to establish an optimum period of observation. Goats are most actively foraging and usually most visible during mid-morning and late afternoon, with mid-morning being the best time. A sample of 14 surveys conducted between 0830 and 1200 h. had a mean of 28.1 goats while a sample of 8 surveys conducted between 1300 and 1900 h. had a mean of 22.5 goats.

Elevations on the southeast face of Mt. Wardle were measured during a field sampling trip on 10 July 1982. Using a THOMMEN 2000 Altimeter-Barometer and a clinometer, elevations at 100 m. intervals were measured and transposed to an oblique photograph of the southwest face. These established contours were then extrapolated to the south and southeast faces of the mountain. The Ecological Land Classification has identified and mapped Ecosites (Table 2.5) on Mt. Wardle. Ecosite boundaries, as determined by the land inventory team, were transcribed from 1:66,000 black and white aerial photographs to the oblique photographs used to plot goat observations (Figs. 2.3, 2.4 and 2.5).

2.2.9. SINCLAIR-STODDART CREEKS SHEEP SURVEYS

Warden records and Canadian Wildlife Service reports indicated that a large proportion of the bighorn sheep population within KNP use the Sinclair Canyon and Stoddart-Shuswap creeks areas during the spring, fall and winter periods. Counts of sheep using the slopes adjacent to Highway 93 through Sinclair Canyon (McKay Cr. to Radium Hot Springs) and Highway 93/95 from Radium Hot Springs to Shuswap Cr. were conducted occasionally during these seasons to determine seasonal range use, herd numbers and composition and

Figure 2.3. Mount Wardle mountain goat winter range: south slopes.

Figure 2.4. Mount Wardle mountain goat winter range: southeast slopes.

Figure 2.5. Mount Wardle mountain goat summer range: southwest slopes.

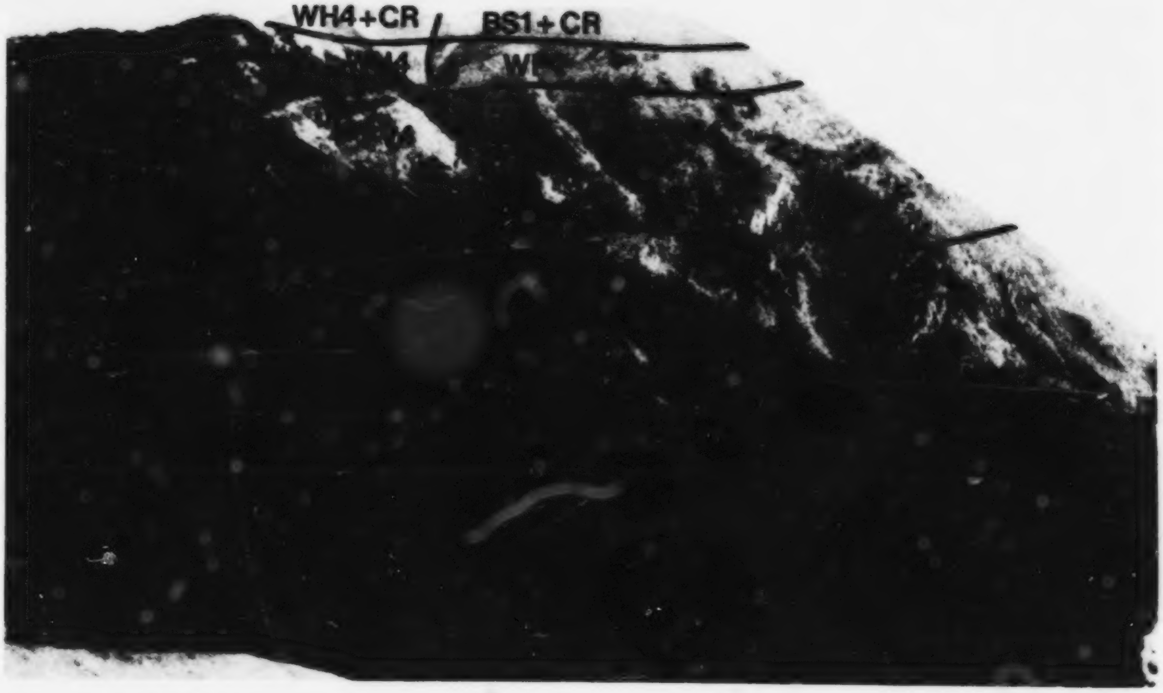

WH4+CR
BS1+CR
WH4
W

Table 2.5. Descriptions of ecosites on the Mt. Wardle study area.

Ecosite	Elevation range (m.)	Ecoregion	Parent Material	Vegetation
DR2	1200-1400	Montane	glacial till	lodgepole pine (C38)
DR7	1200-1300	Montane	ice-contact drift	lodgepole pine (C38)
DG1	1200-1500	Montane	colluvium	white spruce-Douglas fir (C5)
DG3	1300-1500	Montane	colluvium and rock	Douglas fir open (O5) aspen-shrub (C22)
FV4	1900-2300	Lower Subalpine	colluvium and rock	lodgepole pine/green alder/feathermoss (C10) Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4)
SB4	1500-2000	Lower Subalpine	colluvium and rock	Douglas fir/juniper/bearberry (O5) Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4) white spruce/juniper/bearberry (O17) shrubby cinquefoil/bearberry-northern bedstraw (L1)
WF2	2100-2400	Upper Subalpine	colluvium	avalanche complex Engelmann spruce-subalpine fir/grouseberry (C15) Engelmann spruce-subalpine fir/heather (O10)
WH4	2100-2400	Upper Subalpine	colluvium and rock	Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4) unvegetated portions
BS1	2400	Alpine	colluvium	mountain avens-snow willow-moss campion (H1)meadows

productivity. As much as possible the counts were co-ordinated with Warden Service surveys. The results of these surveys are reported in the species account for bighorn sheep.

2.2.10. WINTER TRACK COUNT TRANSECTS

To assess relative densities of ungulates, carnivores, red squirrels and snowshoe hares in different Ecosites and vegetation types in winter, tracks were counted along transects in the snow. Each transect was at least 0.5 km long. Observers identified and recorded all tracks crossing the transect line, calculating density indices for each species based on the number of tracks divided by the number of days since last snowfall times the number of kilometres of transect in that habitat (tracks per km-day).

All birds seen or heard were also recorded but the sample size proved too small to calculate densities of birds.

Snow depth was recorded on each transect to determine the range of snow depths in which each species occurs.

All transects were plotted on aerial photographs and 1:50,000 topographic maps, vegetation described, and elevation recorded in order to assign transects to Ecosites when classification and mapping were completed in 1983.

Tracks per kilometre-day of transect were tallied for each Ecosite and vegetation type The values by Ecosite were used to assign importance rankings for each species of carnivore, small mammal and ungulate to each Ecosite. These values were used in the Ecosite accounts (Volume I) and Master Legend (Map Supplement). Results are also incorporated in habitat sections of Species accounts (below: Section 4).

2.2.11. SMALL MAMMAL TRAPPING

The relative density of small mammals and the composition of small mammal associations (Volume I, Chapter 4) were sampled by two methods. Hares, squirrels and large rodents were sampled by other means (*i.e.* random observations, track count transects, hare pellet counts and circular breeding bird census plots).

Snap Trapping

Museum Special snap traps baited with peanut butter were placed in lines of 50 stations with two traps per station and a 10 m. interval between stations. Snap trap lines were placed within Ecosites, usually in uniform habitat. Lines were set for two nights; thus, most samples consisted of 200 trap nights.

Specimens were collected each morning and assigned a unique field number. Specimens were identified to species, age and sex. A representative sample of each species was flat-mounted on cardboard cards and the skeletons dried, to provide the park with a specimen collection.

Relative density is expressed in terms of individuals captured per 100 trap-nights (TN) with corrections made for sprung traps, including traps in which specimens were captured.

Live Trapping

The primary sampling method for small mammals was snap trapping. Because densities of small mammal populations can vary widely from year to year, live trapping was conducted to establish a reference for the relative densities determined by snap trapping. Live-trapping grids are more time and labour-intensive than snap trapping and are consequently not well suited to sampling a wide variety of habitats.

Small mammals were trapped with folding Sherman live-traps (7.5 cm. x 7.5 cm. x 23 cm.) set in a 10x10 station grid with 10 m. spacing between stations and one trap per station. Traps were checked every day in the morning and also in the evening in high-capture circumstances. Traps were set for a maximum of 5 nights or until the minimum number known alive (MNKA) approached the Lincoln mark-recapture index. Species, sex, weight (on a 100 g. Pesola scale), externally visible reproductive status and station of capture were recorded for each mammal captured. Each new mammal caught was marked for future identification.

The absolute density of a species was the number of individuals trapped in the effectively-trapped area. The effectively-trapped area was the size of the trap grid, extended by the average maximum distance that individuals moved between captures on the grid.

2.2.12. BAT SURVEYS

A QMC mini bat detector was used to gather information on bat activity and distribution in KNP Areas suspected to have concentrations of feeding bats were monitored during the fall of 1981 and 1982, and during the spring of 1982 and 1983 to determine arrival and departure dates for migrating bats. The bats were identified to species when possible, and time and number of bat passes were recorded to assess activity. Bat detectors were used during owl surveys in the spring of 1982 and 1983, but this was determined to be an unproductive method to monitor bats. Random checks of sites in the Sinclair Canyon and Kootenay valley were made during the summer of 1982 to supplement knowledge gained by extensive bat surveys conducted in July 1982 and 1983 (Fenton *et al.* 1983).

2.2.13. RIVER SURVEYS

To determine the wildlife use of the larger rivers within KNP trips were made by kayak down the Kootenay River. Data were recorded suitable for inclusion on Mountain Parks Wildlife Survey Data Forms (MPWSDF) for all mammals, raptorial birds and waterfowl species observed and on all other birds using the river or unvegetated riverbank habitat.

2.2.14. RANDOM OBSERVATIONS

All wildlife observations were recorded on the MPWSD Forms and added to the computer file of park wildlife data stored in the Canadian Soil Information System (CANSIS) computer in Ottawa. Information recorded includes:

watershed
topographic position
aspect
elevation
habitat (based on vegetation type)
snow depth (where applicable)
proximity to water

2.2.15. DATA REVIEW

Literature searches were conducted manually at the KNP library at Radium Hot Springs, the Canadian Wildlife Service library in Edmonton, the B.C. Fish and Wildlife Branch library in Victoria, the University of British Columbia library, and the B.C. Provincial Museum. A computer search was conducted through the Environment Canada Data Base Services in Ottawa.

In addition to published and unpublished reports and books located through the above sources, much park-specific wildlife information was obtained through the Parks Canada computerized wildlife sighting card system referred to in section 2.2.15 above (henceforth referred to as park wildlife cards); warden diaries and monthly reports (warden files); naturalists field notes and reports (naturalis files), and Superintendent's reports.

Further information, in the form of correspondence, annual reports and summaries by superintendents and park wardens, and old files, was summarized by Geoff Holroyd in the Public Archives of Canada, Ottawa:

Reading Group 84, Volumes 34, 114 to 122, 155, 156, 157, 166, 167, 179, 180, 190, 229, 477, and 585.

3. RESULTS

3.1. BREEDING BIRD CIRCLES

A total of 605 circular bird census plots was sampled in KNP. Of these, 242 were in the Montane Ecoregion, 190 in the Lower Subalpine and 162 in the Upper Subalpine, and 11 in the Alpine.

A total of 88 species was recorded on circular bird census plots, with the highest counts being, in descending order:

> Townsend's Warbler (609), Dark-eyed Junco (568), Pine Siskin (564), Swainson's Thrush (506) and Yellow-rumped Warbler (474)

Results of circular bird census plots were used to define breeding bird communities in Volume I (Poll and Porter 1984) and to assess habitat use by species in the Ecosite accounts in Volume I (Walker *et al.* 1984) and species accounts in section 4. of this volume. Density indices (DI) were calculated for each species on each Ecosite and vegetation type where it occurs; these values allow comparison of the relative densities of various species in various habitats.

3.2. SPRING MIGRATION SURVEYS

Twenty-five migration surveys were conducted from 2 March until 14 June 1982.

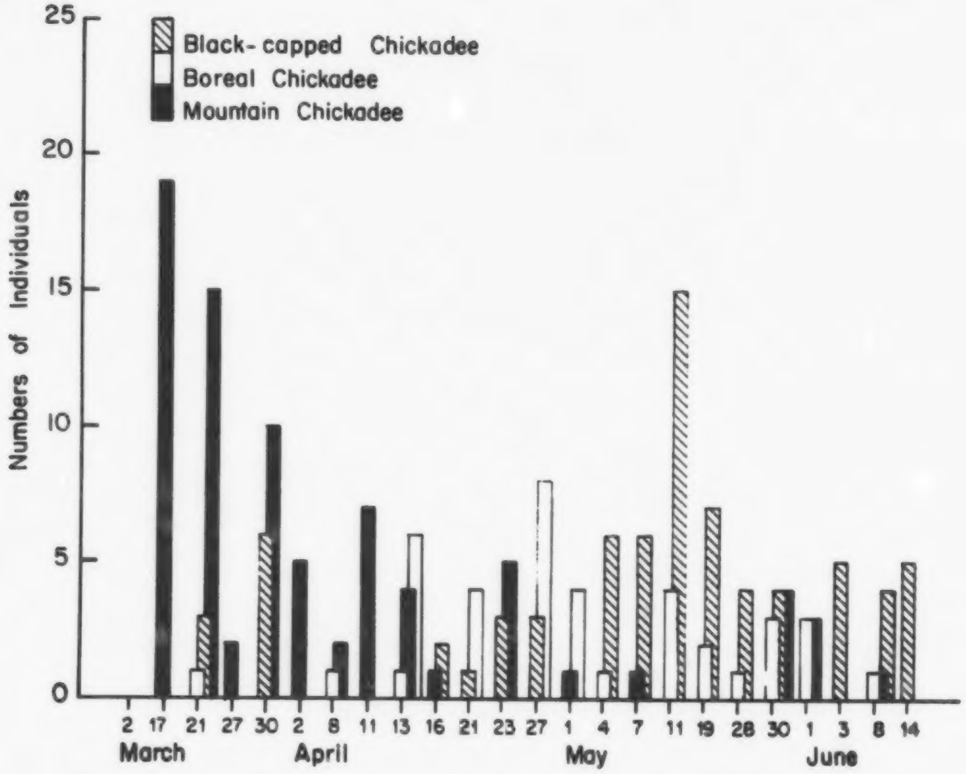
A total of 5799 individuals of 74 species was recorded. The highest count of species was 40 on 1 June while the peak number of individuals, 424, was on 3 June. The species with the highest count during the survey was the Dark-eyed Junco with 104 on 27 April. The Fringillidae had the greatest number of species on a given survey (6). Members of the Corvidae and Picidae were present on all twenty-five survey dates.

March

Surveys in early March yielded low numbers of residents. The Common Raven reached a peak of 16 individuals and was the dominant species. In mid-March the Mountain Chickadee peaked at 19 (Figure 3.1). Numbers dropped from 17 March to late April. Several Pine Grosbeaks were recorded during mid-March, but were no longer recorded after mid-April. A winter visitor, the Common Redpoll, occurred in small flocks through March and peaked at 20 on 2 April. They had left the park by early May. The Bohemian Waxwing was last seen on 27 March, when a flock of 10 was recorded in the Kootenay valley.

During March four new species of migrant arrived in the park. On 17 March two American Robins and one Dark-eyed Junco were recorded. Two Varied Thrush were seen on 27 March. Resident American

Figure 3.1. Chickadee, spring migration in Kootenay, 1982.



Dippers initiated territorial singing along Sinclair Creek by 30 March. The Bald Eagle was the only raptor seen before April.

April

Early April marked the arrival of two species of swallow, the Violet-green Swallow and the Barn Swallow. Starlings appeared and quickly peaked at 26 in the Kootenay valley by 13 April.

The first Northern Flicker was sighted on 8 April and the peak count was 28 on 27 April (Figure 3.2). Yellow-bellied Sapsuckers arrived at the end of the month. American Crow and Steller's Jay were not conspicuous until mid-April. Four Buteo species were recorded: a Red-tailed Hawk was sighted on 11 April and up to three were recorded on subsequent surveys; a Golden Eagle was seen once, on the 16 April survey; and a Swainson's Hawk was observed once at the end of the month.

Resident American Dippers were most vocal along Sinclair Creek in mid-April. Several Townsend's Solitaires were seen on 13 April, but there were no subsequent records. Solitary Mountain Bluebirds were sighted along the Kootenay floodplain until early May.

During late April the first Killdeer was observed along the river. One of the more spectacular migrations took place through the Sinclair Canyon at this time. A flock of 50 Rosy Finches was seen on 21 April and 85 during early May. Small flocks of Water Pipits also remained along the Kootenay floodplain during April and had departed by late April.

Several Western Meadowlarks were sighted along the grassy roadside in the Kootenay valley from 11 to 21 April. Several members of the sandpiper family arrived from mid to late April. Individual Spotted Sandpipers were sighted along the Kootenay River, and a Snipe was winnowing near Dolly Varden Creek. Winter Wrens were heard singing in late May in Sinclair Pass and Boreal Chickadees reached their highest numbers (8) in the Kootenay valley (Figure 3.1).

The first warbler, the Yellow-rumped Warbler, arrived on 27 April. Varied Thrushs and American Robins both peaked in numbers at this time, with 65 and 75, respectively (Figure 3.3).

Both species of kinglet were present. The Golden-crowned Kinglet is resident in the park but increases in numbers recorded during the breeding season. Two Ruby-crowned Kinglets were observed on 23 April and their song quickly became one of the predominant sounds along the route. They peaked at 43 on 7 May (Figure 3.4).

The most abundant bird along the route through April and May was the Dark-eyed Junco. This species was recorded on all but one survey from 17 March until 14 June and reached a peak of 104 individuals on 27 April (Figure 3.5).

May

May brought insectivorous species such as vireos, warblers and flycatchers to the park. The first Solitary Vireo and Savannah Sparrow were seen on 1 May and four Cedar Waxwings were seen on 7 May. This was the only waxwing species along the route for the rest of the migratory season.

Three blackbird species were seen in May in the Kootenay valley. Small numbers of Brewer's Blackbird were seen from early May through June and a single Red-winged Blackbird was recorded in mid-May. The Brown-headed Cowbird was first seen on 11 May and reached a maximum of 15 by 11 June (Figure 3.6). Both the Townsend's Warbler and Orange-crowned Warbler arrived in mid-May. The Orange-crowned Warbler peaked at eight on 19 May and the Yellow-rumped Warbler peaked at 40 on the same date (Figure 3.7).

Hammond's Flycatcher and Olive-sided Flycatcher were first sighted on 11 May and Hammond's Flycatchers quickly became the dominant flycatcher, increasing to 34 in mid-June. The Olive-sided Flycatcher reached a maximum of six on 28 May. The Western Wood-Pewee arrived in late May, peaking at seven on 30 May (Figure 3.8).

Figure 3.2. Northern Flicker, spring migration in Kootenay, 1982.

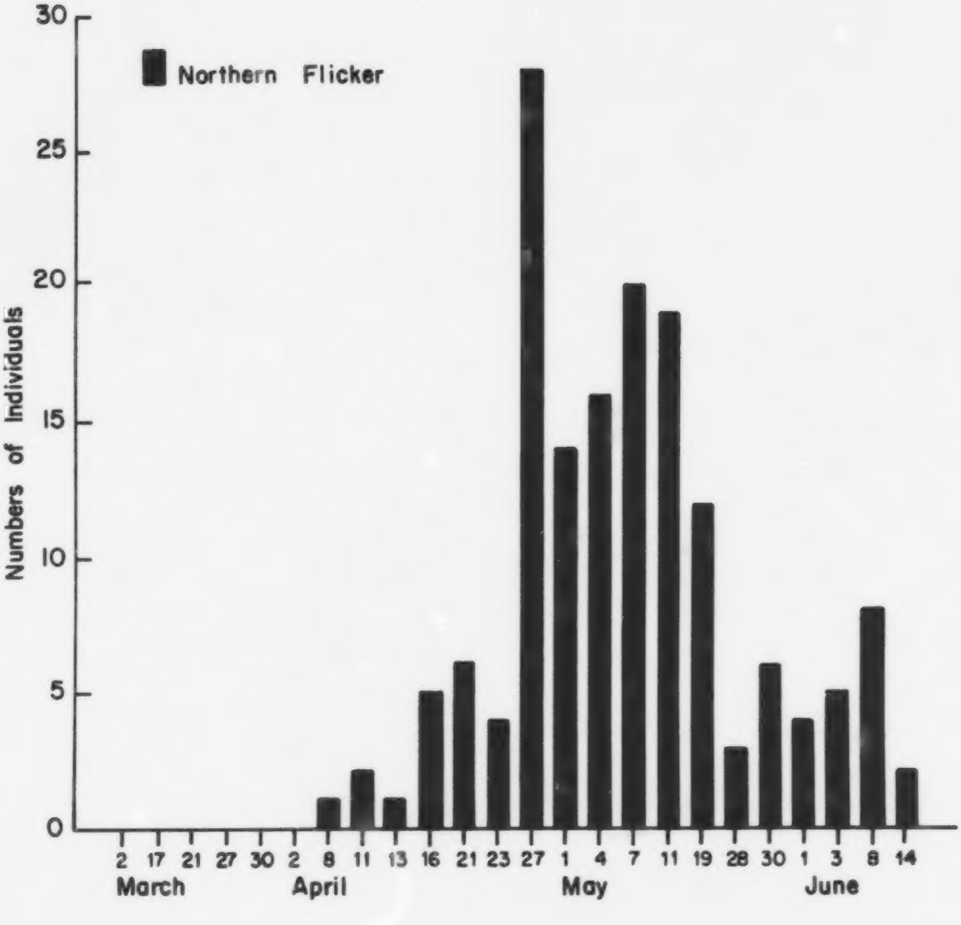


Figure 3.3. American Robin and Varied Thrush, spring migration in Kootenay, 1982.

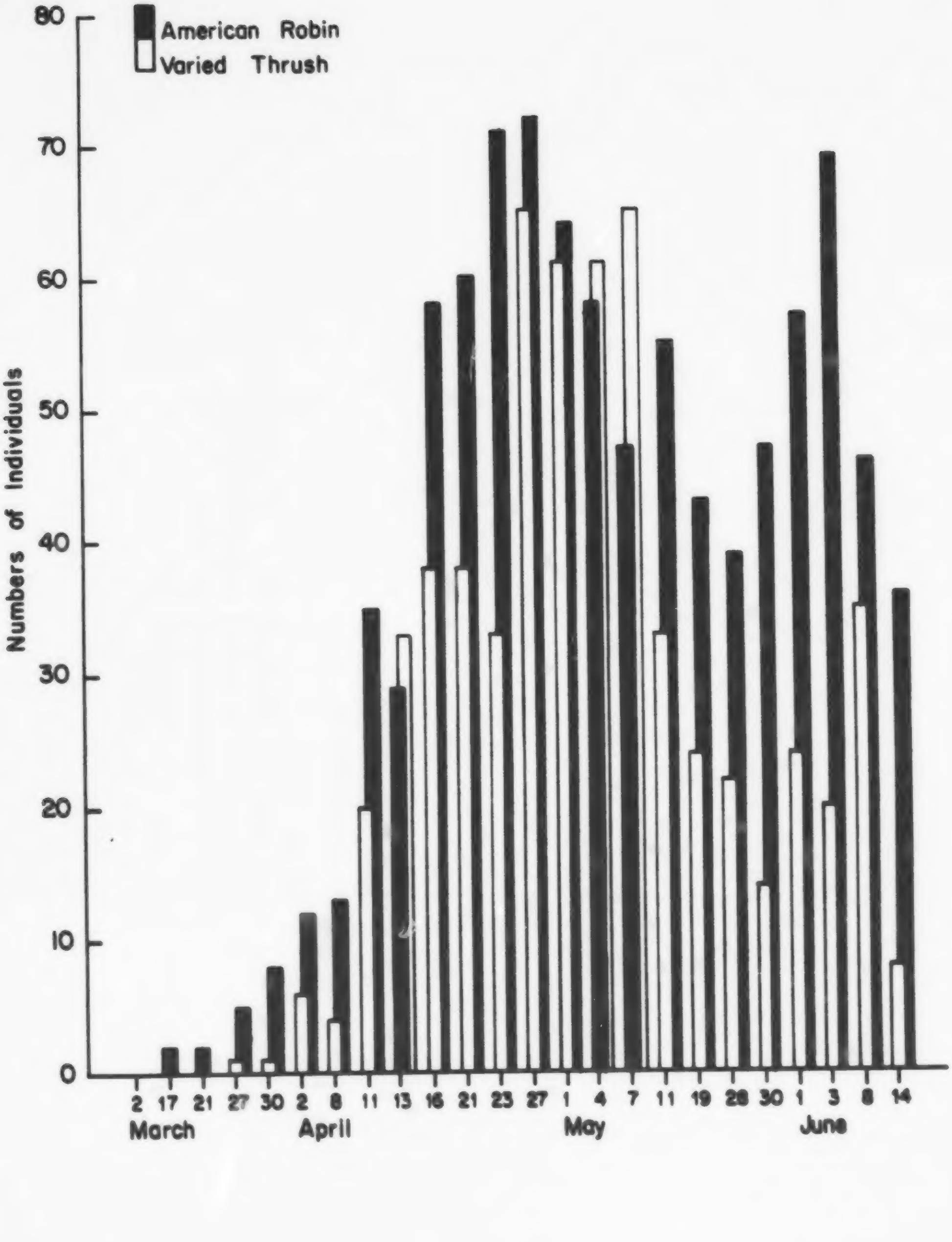


Figure 3.4. Kinglet, spring migration in Kootenay, 1982.

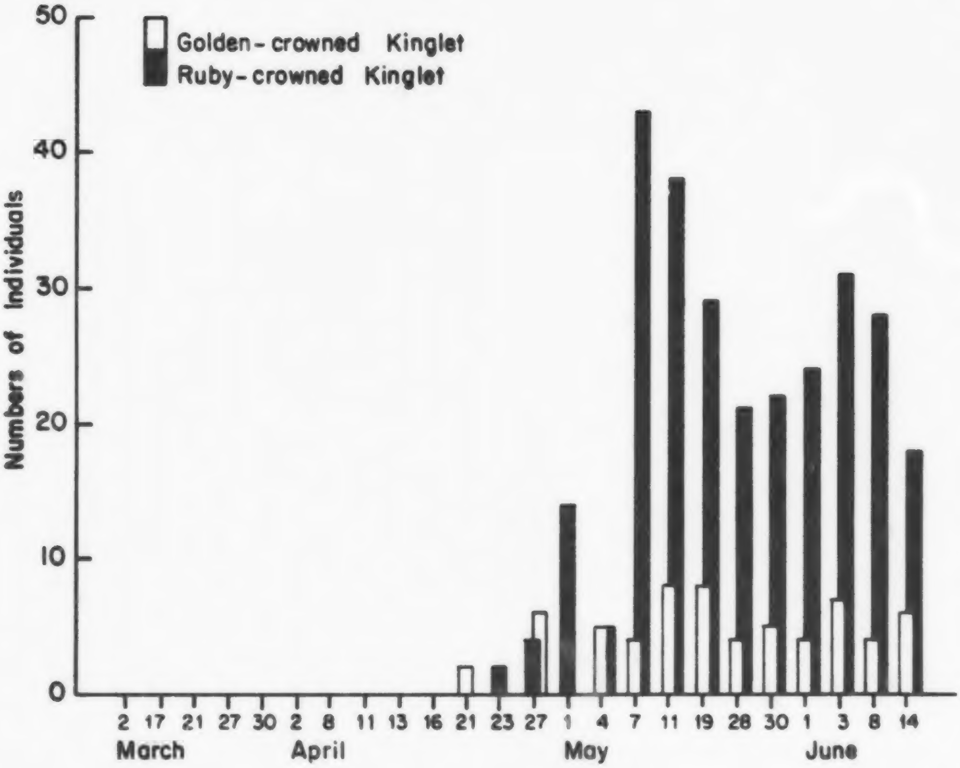


Figure 3.5. Dark-eyed Junco and Chipping Sparrow, spring migration in Kootenay, 1982.

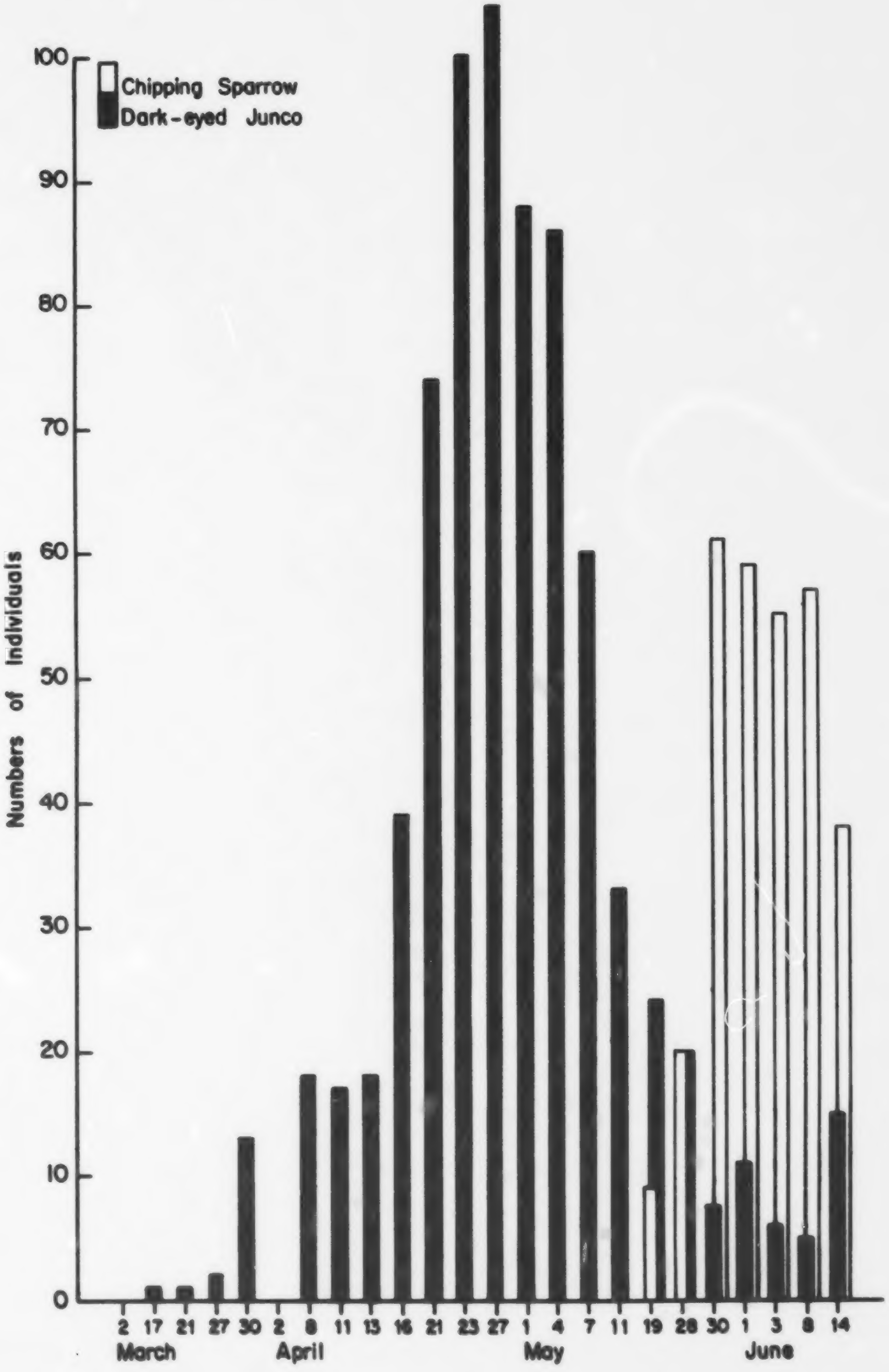


Figure 3.6. Brown-headed Cowbird, spring migration in Kootenay, 1982.

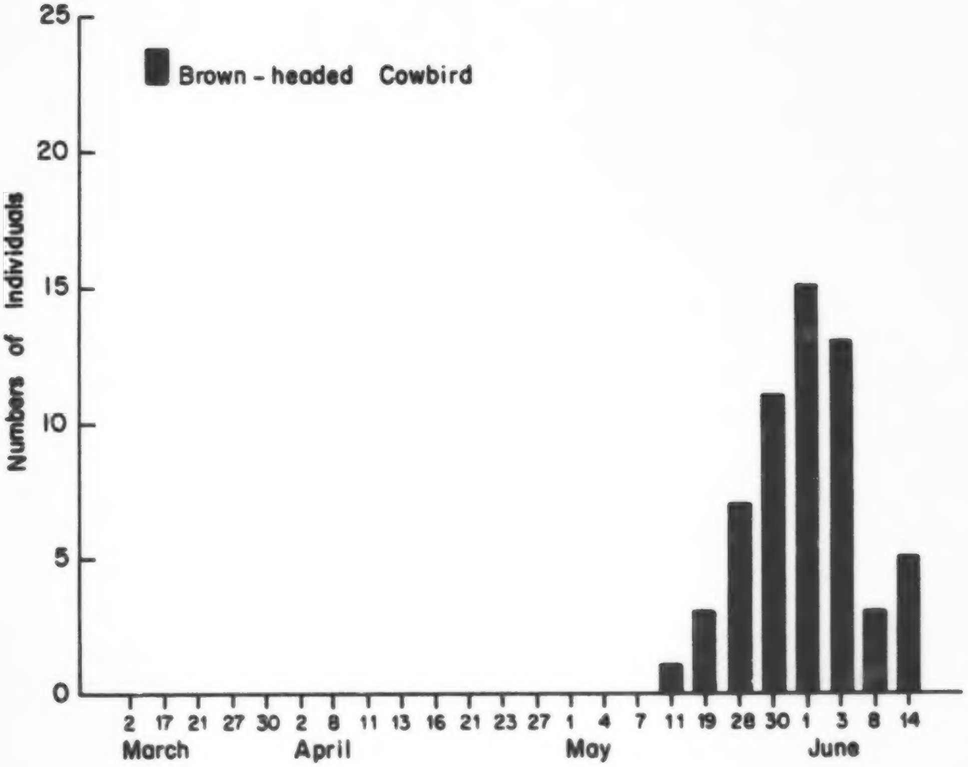


Figure 3.7. Orange-crowned Warbler, Townsend's Warbler and Yellow-rumped Warbler, spring migration in Kootenay, 1982.

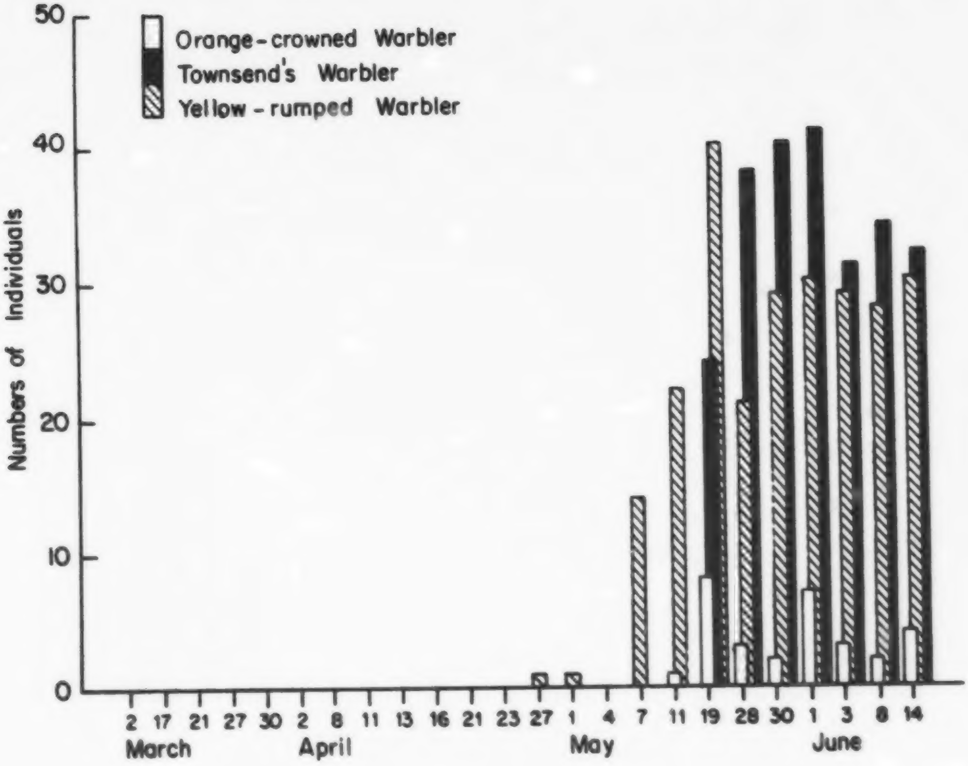


Figure 3.8. Hammond's Flycatcher and Western Wood-Pewee, spring migration in Kootenay, 1982.

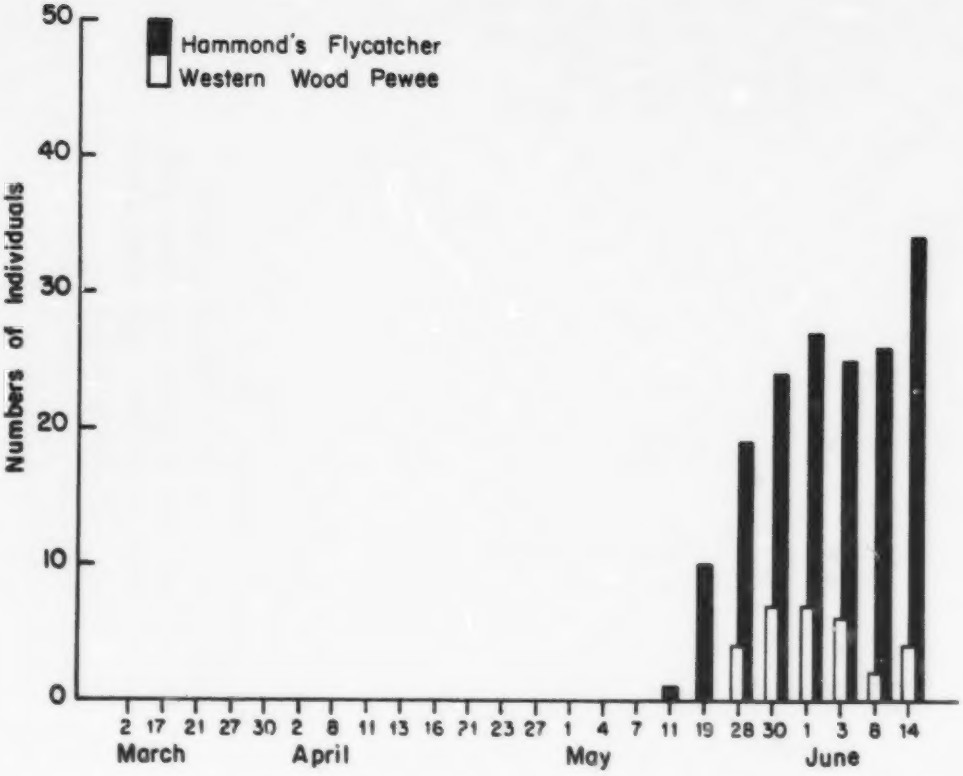


Figure 3.9. Solitary Vireo and Warbling Vireo, spring migration in Kootenay, 1982.

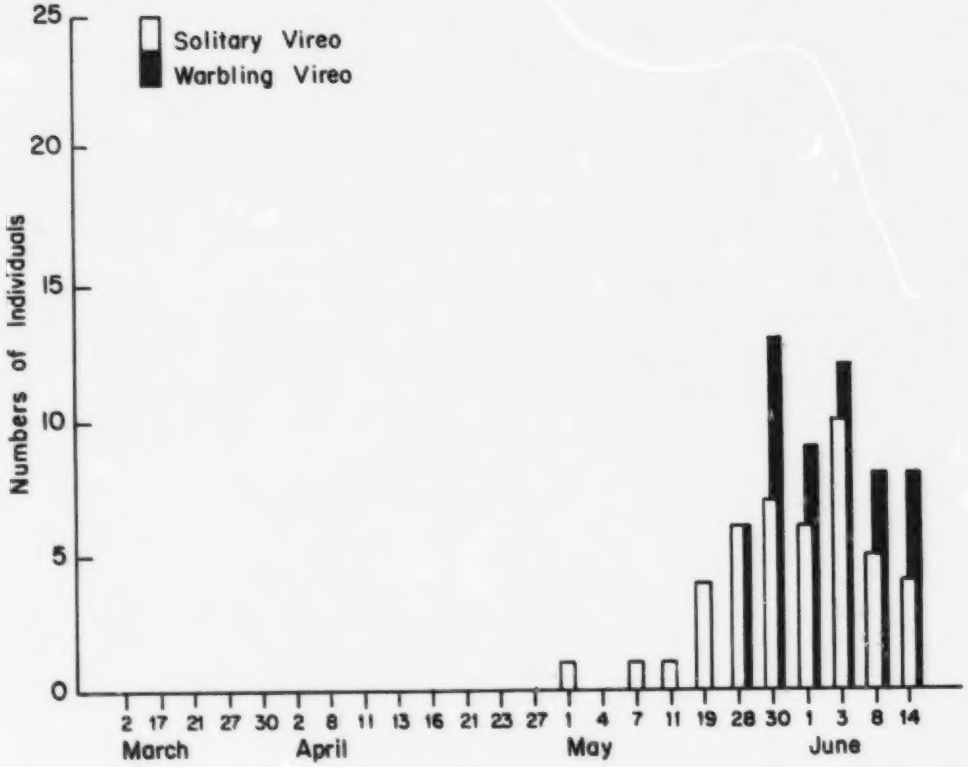
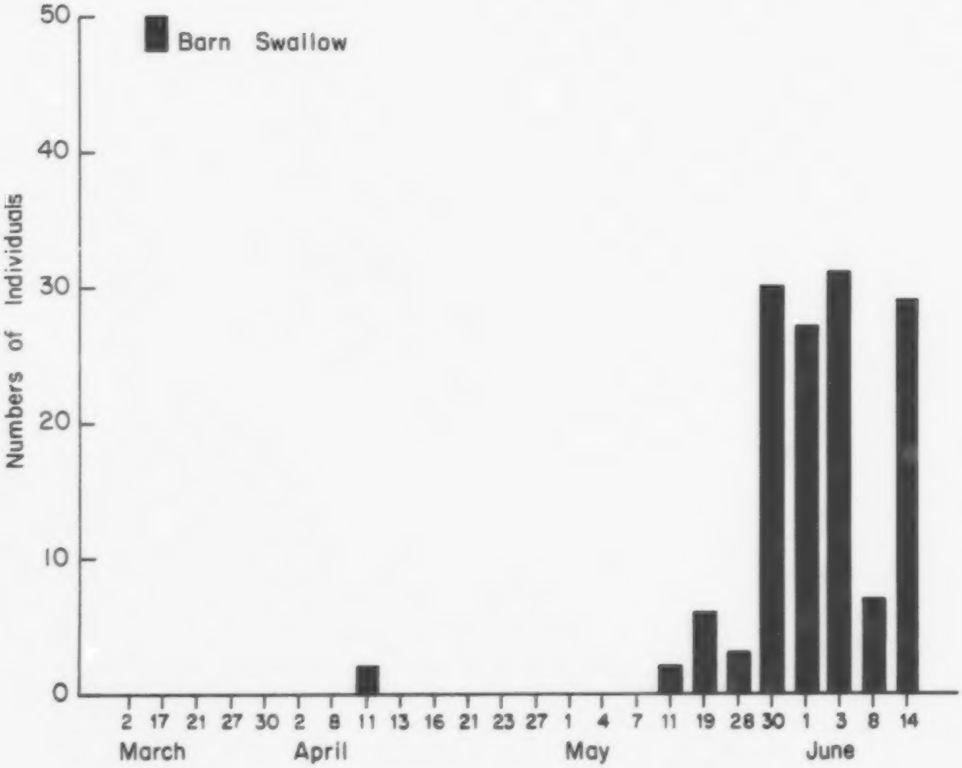


Figure 3.10. Barn Swallow, spring migration in Kootenay, 1982.



Warbling Vireos arrived later in the month than Solitary Vireos but by 30 May had outnumbered them with a count of 13 (Figure 3.9).

The rest of the sparrows moved into the park from mid- to late May, including White-crowned Sparrow, Song Sparrow, Vesper Sparrow and Chipping Sparrow. All species were present along the Kootenay valley in small numbers except the Chipping Sparrow which quickly became, with the Dark-eyed Junco and American Robin, one of the dominant species along the route. A total of 61 Chipping Sparrows was counted on 30 May and high counts continued until the end of the survey (Figure 3.5).

By late May small numbers of Hermit Thrushs were present until they moved to higher elevations in early June. The first Swainson's Thrush was recorded on 28 May and numbers were still increasing when surveys ceased in mid-June. Solitary Rufous Hummingbirds were recorded in the Kootenay valley during late May.

The numbers of Barn Swallows stabilized at about 30 along the route until 8 June when nests on park buildings were destroyed. By 14 June they had returned to their previous level of abundance (Figure 3.10) Pine Siskins peaked at 21 on 8 June.

3.3. BREEDING BIRD CENSUS PLOTS

The results of the two breeding bird census plots conducted in KNP during June and July 1983 have been presented in detail elsewhere (***American Birds***, Vol. 38, Jan-Feb 1984). The specific plot locations, and estimated locations of breeding male territories, are in Figures 3.11 and 3.12, and summarized results are below:

Montane Mixed Forest:(FR3; C44)

Location: Dolly Varden fire road, 3.2 km. north of Crook's Meadow, Kootenay National Park.(NG670313)
Size: 14 ha (350m X 400m).
Census: [1]

Dark-eyed Junco	5(36,15)	Hammond's Flycatcher	3.5(25,10)
Swainson's Thrush	2	Golden-crowned Kinglet	2
Orange-crowned Warbler	2	Yellow-bellied Sapsucker	1
Hairy Woodpecker	1	American Robin	1
Townsend's Warbler	1	Western Wood-Pewee	0.5
Olive-sided Flycatcher	0.5	Warbling Vireo	0.5
Purple Finch	0.5	Rufous Hummingbird	+
Ruby-crowned Kinglet	+	Yellow-rumped Warbler	+
Chipping Sparrow	+		

Total: 17 Species: 20.5 territorial males ($146/km^2$, 59/100 acres).

Visitors:

Northern Flicker
Black-capped Chickadee
Cedar Waxwing
Pine Grosbeak
Red Crossbill

Gray Jay
Mountain Chickadee
Western Tanager
Pine Siskin

Montane Open Douglas Fir Forest(WY2; O5, H6):

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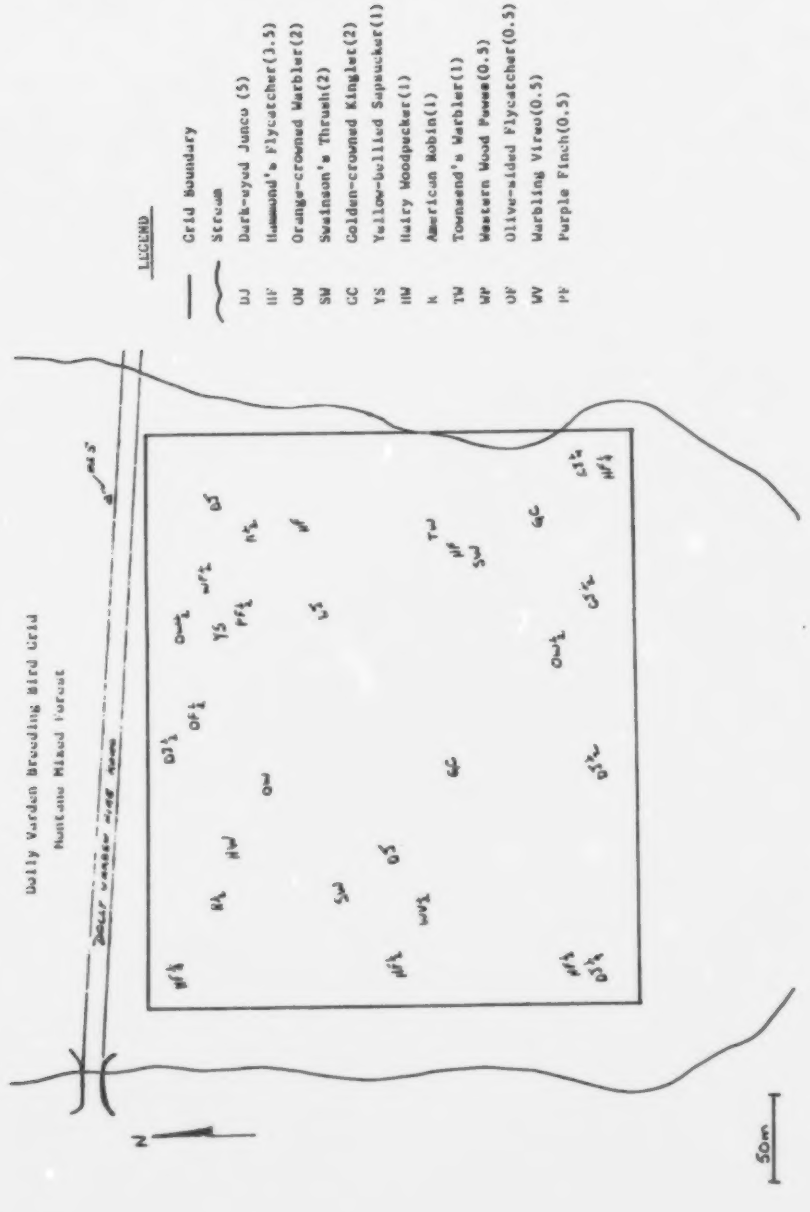
[1] Numbers represent the number of territories on the plot, followed in brackets first by density of territories per km^2, and then by density of territories per 100 acres

Figure 3.11. Field data sheet for Dolly Varden breeding bird census plot.


Dolly Varden Breeding Bird Grid
Montane Mixed Forest
Dolly Varden Fire Road
N
50m
LEGEND
Grid Boundary
Stream
DJ Dark-eyed Junco (5)
HF Hammond's Flycatcher(3.5)
OW Orange-crowned Warbler(2)
SW Swainson's Thrush(2)
GC Golden-crowned Kinglet(2)
YS Yellow-bellied Sapsucker(1)
HW Hairy Woodpecker(1)
R American Robin(1)
TW Townsend's Warbler(1)
WP Western Wood Pewee(0.5)
OF Olive-sided Flycatcher(0.5)
WV Warbling Vireo(0.5)
PF Purple Finch(0.5)

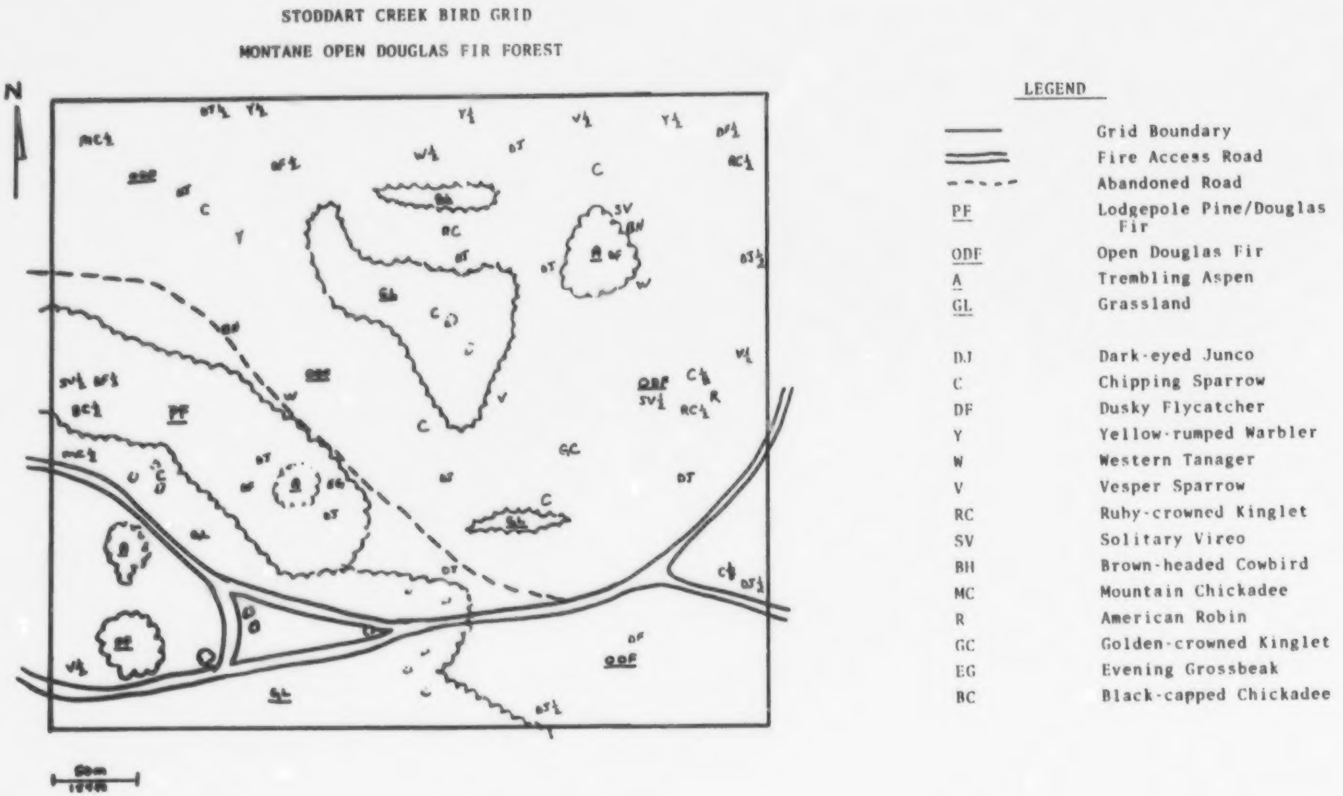

STODDART CREEK BIRD GRID
MONTANE OPEN DOUGLAS FIR FOREST
N
LEGEND
Grid Boundary
Fire Access Road
Abandoned Road
PF Lodgepole Pine/Douglas Fir
ODF Open Douglas Fir
A Trembling Aspen
GL Grassland
DJ Dark-eyed Junco
C Chipping Sparrow
DF Dusky Flycatcher
Y Yellow-rumped Warbler
W Western Tanager
V Vesper Sparrow
RC Ruby-crowned Kinglet
SV Solitary Vireo
BH Brown-headed Cowbird
MC Mountain Chickadee
R American Robin
GC Golden-crowned Kinglet
EG Evening Grossbeak
BC Black-capped Chickadee
50m

Figure 3.12. Field data sheet for Stoddart Creek breeding bird census plot, KNP.

Location: Eight km. SE of Radium Hot Springs, above Stoddart Cr., Kootenay National Park. (NG698018)
Size: 18 ha (400 X 450m).
Census:

Dark-eyed Junco	10.5(58,24)	Chipping Sparrow	6.5(36,15)
Dusky Flycatcher	4.5(25,10)	Yellow-rumped Warbler	2.5(14,7)
Western Tanager	2.5	Vesper Sparrow	2.5
Ruby-crowned Kinglet	2	Solitary Vireo	2
Brown-headed Cowbird	2	Mountain Chickadee	1
American Robin	1	Golden-crowned Kinglet	1
Evening Grosbeak	1	Black-capped Chickadee	.5
Cooper's Hawk	+	Common Nighthawk	+
Townsend's Warbler	+	Cassin's Finch	+

Total: 18 species: 39.5 territorial males (219/km^2, 89/100 acres).

Visitors:

Blue Grouse
American Crow
Red Crossbill
Common Raven
Pine Siskin

3.4. OWL SURVEYS

A total of 13 systematic surveys were conducted, six in 1982 and seven in 1983 (Table 3.1). The commonest species recorded was the Boreal Owl, which occurred on eight surveys, the highest count being six on 6 April 1983. The second commonest species was the Northern Pygmy-Owl, recorded on six surveys with a highest count of three on 9 May 1982 and 13 April 1983.

Most owl records were in the Kootenay valley portion of the survey route. Only Barred and Northern Pygmy-Owl were recorded in the Sinclair Cr. or Redstreak areas.

3.5. POND SURVEYS

The ponds that were surveyed regularly are listed below in the order that they occur from south to north. The results have also been incorporated into the species accounts.

The Montane Ecoregion of the lower Kootenay valley contains an extensive network of ponds and wetlands. Most of the data on the breeding phenology of the park's amphibians were collected from these ponds. Several areas, such as the Kootenay Ponds, were found to be especially important for breeding amphibians. The Vermilion valley contains a few small ponds and bodies of standing water in the Lower Subalpine Ecoregion. They are used primarily by the western toad for breeding. High subalpine lakes occur at the north end of the park but they are not important to amphibians although they are used occasionally by migrating waterfowl and shorebirds.

Table 3.1. Results of owl surveys, KNP.

Date	Great Horned Owl	Northern Pygmy-Owl	Barred Owl	Great Gray Owl	Boreal Owl	Northern Saw-whet Owl	Total
1982							
4 March							0
1 April	1(K)		1(R)				2
19 April	2(K)			1(K)	1(K)		4
9 May		1(S), 2(K)			2(K)		5
13 May		1(S)			1(K)		2
19 May							0
1983							
31 March							0
6 April		2(K)			6(K)		8
13 April		1(R), 2(K)	1(R)		5(K)		9
19 April					4(K)	1(K)	5
28 April		1(K)			4(K)		5
5 May					4(K)		4
12 May		1(S), 1(K)	1(K)				3

R = Redstreak, open Douglas fir forest
S = Sinclair Pass area
K = Kootenay valley

1. COBB LAKE (NG794124) elevation: 1276 m.

This small lake is about eight m. at its greatest depth. It is situated in coniferous forest and drains from the north end into Swede Creek. A narrow strip of floating moss and sedges at the shoreline is the only emergent vegetation.

A small colony of little brown bats is located near the lake, and they feed over the water's surface after dusk. Adult spotted frogs inhabit the west shoreline of the lake, and an adult western toad was found on the south shore.

Buffleheads and Spotted Sandpipers were seen during migration. Mallards are the only duck species known to breed at this location.

2. SETTLER'S ROAD BEAVERPONDS (NG780185) elevation: 1170 m.

Beavers maintain dams and a lodge at this site. The ponds are surrounded by dwarf birch-shrubby cinquefoil-willow/brown moss (S1) wetlands.

Three adult spotted frogs were present in late May 1981 but there was no evidence of breeding.

Canada Geese and Lesser Scaups have been recorded during migration (park wildlife cards). A pair of Mallards was seen in late May of 1981, and a female Bufflehead in late May 1982. A Solitary Sandpiper was seen at the same time.

Lincoln's Sparrows and Song Sparrows occur in the shrubby wetlands between the ponds and adjacent forest. Tree Swallows nest in dead snags standing in the water.

3. NIXON LAKE **(NG754211) elevation: 1183 m.**

Nixon Lake is a large, shallow pond with a depth no greater than one metre. A spring feeds this pond at the north end, and a creek flows from the south end to the Kootenay River. The east and west shores are bordered with floating mats of brown moss which give way to moss tussocks covered by Labrador tea, dwarf birch, and shrubby cinquefoil. A sedge marsh extends across the south end of the pond.

All four species of amphibians found in KNP occur at Nixon Lake.

Long-toed salamander eggs were laid by mid-May 1982 on stems of vegetation near shore, and larvae hatched by 31 May. Water temperatures ranged from 18-19°C at this time. Larvae were observed to overwinter and remain active where springs maintain ice free areas. Juvenile wood frogs and spotted frogs gather during spring in small ponds along the lakeshore where the water temperature may be 10°C higher than the open water. A juvenile spotted frog was active in the open water of the north end of the pond in early February 1983 (L. Halverson pers. comm.).

A Ring-necked Duck nested in the marsh in June 1979. Twelve ducklings were seen with a female Bufflehead in July 1981, and several pairs were engaged in mating displays in late May 1982. Mallards have been seen during spring migration.

Lincoln's Sparrows occur in the shrubland adjacent to the pond.

4.CONSERVATION CORPS POND **(NG765230) elevation: 1189 m.**

Small ponds, sloughs, and dwarf birch-shrubby cinquefoil-willow/brown moss (S1) wetlands cover an area northeast of the Conservation Corps Camp and are fed by a flow originating at Dog Lake. A small creek drains the southwest corner of the largest pond, where horsetail beds attract moose during summer.

Both species of frog, and western toad occur in the area. Adults were found primarily in the sedges bordering the largest pond and are thought to breed here.

Western toad tadpoles develop in small, shallow pools of water formed on mudflats behind the pond. During July 1982 these pools were 20°C and 5 cm in depth and by August 1982 had completely dried up.

Killdeer, Solitary Sandpipers, Common Snipe and Soras were seen during the summer. A pair of Solitary Sandpipers with two young were seen in August 1982, and probably nested in the area. Killdeer were seen giving distraction displays and probably bred. A female Mallard was present in late August 1982. Common Yellowthroats, Savannah Sparrows and Lincoln's Sparrows were observed singing in the shrubby wetlands and mudflats. Fledgling Common Yellowthroats and Lincoln's Sparrows were present in August 1982.

5. CONSERVATION CORPS CAMP BRIDGE POND **(NG763221) elevation: 1158 m.**

This is a seasonal pond in an old gravel pit adjacent to the Kootenay River. The water level diminishes throughout the summer.

Although adult western toads have been seen in the vicinity, the pond is not used by amphibians.

Waterfowl use this pond in small numbers during spring migration. A female Bufflehead was seen several times during June 1982. Mallards, Blue-winged Teals and Northern Shovelers were seen in late June 1982. Killdeers were summer residents in the area, and probably nested.

6. *MEADOW CREEK BEAVER PONDS* (NG739231) elevation: 1215 m.

A pocket of poplar along Meadow Cr. attracted beaver, and their dam has created a large pond several metres in depth. A lodge remains at the site and the dam has been maintained during recent years, although beaver were not observed there during surveys.

The shoreline extends into the forest, and snags are common around the periphery of the pond. Aquatic vegetation is sparse.

A pair of Bufflehead with three young were seen in July 1981. A female Bufflehead and a Spotted Sandpiper were seen in June 1982. Tree Swallows are present and may nest in the dead snags created by the pond.

7. *DOG LAKE* (NG756258) elevation: 1184 m.

Dog Lake is the largest freshwater body in the Kootenay valley and has a maximum depth of over 4.5 m. A smaller pond exists at the southern end of the lake. Emergent sedges are abundant at the north and south shorelines and an extensive dwarf birch-shrubby cinquefoil-willow/brown moss (S1) wetland is formed between the lake and the pond.

This is an active site for beaver, with a dam maintained where Dog Creek drains the lake. A second lodge was constructed along the west shore in 1982.

Both species of frog, and the western toad occur in the emergent vegetation at shoreline. Shallow waters along the southeast shore contained hundreds of strings of western toad eggs in May 1982 which hatched by the end of the month.

Waterfowl breed in the marsh at the south end of Dog Lake. A brood of eight Ring-necked Ducks was produced in July 1981, and three young were seen in August 1982. The first recorded nest for the Canada Goose in the park was found in the south marsh in late May 1981. A female Mallard with six ducklings, and an adult American Coot with two young were seen in July 1981. In early September a female Blue-winged Teal with a single duckling was seen along the east shore. Dog Lake is one of the most important areas for migrating waterfowl. Common Loons and Western Grebes occur with many species of diving ducks including Buffleheads, Ring-necked Ducks, Barrow's Goldeneyes, White-winged Scoters, and Surf Scoters.

Spotted Sandpipers and Killdeers nest along the gravelly north shore. Solitary Sandpipers and Soras are resident during summer. Red-winged Blackbirds nest in the marshy vegetation at the north end of the lake. Five species of swallows feed over the water's surface. The shrubby wetlands contain Willow Flycatchers, Common Yellowthroats, and Lincoln's Sparrows. The only park records for Le Conte's Sparrow and Clay-coloured Sparrow were reported during spring migration in 1975 (Van Tighem 1977). There is one autumn record of a migrating Rusty Blackbird.

8. *DAER POND* (NG741275) elevation: 1187 m.

This is a large, shallow pond with extensive water sedge-beaked sedge (H11) marshes at its north and south ends. Several creeks feed into the pond and it is drained via Daer Cr.

Both the spotted frog and wood frog occur at Daer Pond. Emergent sedges provide cover for breeding; no eggs or tadpoles were found.

Daer Pond is an important area for migrating waterfowl. A female Mallard produced a brood of eleven ducklings in June 1983. Killdeer nested on a gravel bar on the northwest shore. Four eggs were laid by 12 May 1983. Spotted Sandpipers, Solitary Sandpipers, Soras and Common Snipe are summer residents. A Lesser Yellowlegs and a Baird's Sandpiper were seen in the sedge marsh during spring migration in May 1983.

Ospreys and Great Blue Herons visited occasionally during the summer to feed in the pond. Red-winged Blackbirds nested in the area and fledged young were seen by early July 1982.

9. DOLLY VARDEN CREEK (NG695300 to NG652342) elevation: 1218 m.

The Dolly Varden Creek area is a mosaic of water sedge-beaked sedge (H11) meadows and dwarf birch-shrubby cinquefoil-willow/brown moss (S1) wetlands, with several beaver ponds. There is a considerable diversity of habitats in this area due to the complexity of the Ecosites occurring here.

Three species of amphibians occur throughout the wetlands: western toads, spotted frogs and wood frogs. Western toad tadpoles were found along the shorelines of small ponds.

Mallards and Buffleheads were seen on beaver ponds during the summer. Common Snipe are resident during summer and probably nest in the marshes. Barrow's Goldeneyes, Solitary Sandpipers and Spotted Sandpipers occur during migration.

The Dolly Varden wetlands contain a diversity of songbirds. Many of these are confined to this habitat and are uncommon throughout most of the park. These include: Alder Flycatcher, Willow Flycatcher, Yellow Warbler, Lincoln's Sparrow, Song Sparrow and Savannah Sparrow.

10. SUNDEW POND (NG667357) elevation: 1265 m.

Sundew pond is a shallow body of water not exceeding two metres in depth. A floating mat of dwarf birch-shrubby cinquefoil-willow/brown moss (S1) forms the shoreline. Emergent vegetation such as sedges and cattails provide abundant cover within the pond and adjacent sloughs.

Only one species of amphibian, the wood frog was found at Sundew Pond. Juveniles were common in the wet moss bordering the shore. A maximum of 19 were caught on 8 July 1982.

A pair of Pied-billed Grebes was seen on the pond during several visits in the summer of 1982, and again in late May 1983. Common Snipes and Soras occurred in the wetlands and may breed in the area. Mallards, Ring-necked Ducks, Lesser Scaups, Buffleheads, American Coots and Killdeer were recorded during spring migration. Common Yellowthroats are common in the shrublands and four species of swallows feed in the area.

11. KOOTENAY PONDS (NG675380 to NG673383) elevation: 1213 m.

The Kootenay Ponds are two small kettle ponds north of Kootenay Crossing. The main pond is adjacent to Highway 93 in an opening in the mixed forest. Aquatic vegetation is very limited, and the shoreline is rocky with little vegetation. A few logs and other debris along the south shore are used for cover by amphibians during the breeding season.

Long-eared bats forage over the shoreline of the main pond.

All amphibian species known in KNP are found at the Kootenay Ponds. Immediately after spring break-up in late April long-toed salamanders congregate to breed under any available cover along the south shore. By 20 May 1982 numbers had peaked at 32 adults. Salamanders were seen crossing Highway 93 during a wet evening on 23 May 1982 (naturalist files). Eggs were detected on aquatic vegetation near the northwest shore as early as 10 May 1983. At the second Kootenay Pond 15 adult long-toed salamanders were found along the south shore. Eggs are laid in shallow water areas. By late June all adults have disappeared from the ponds, and larvae appear by early July.

There is one spotted frog record for Kootenay Pond, an adult seen on 26 May 1981.

Wood frogs breed from early to mid-May. A maximum of 32 adults and juveniles were counted in vegetation along the shoreline of the second Kootenay Pond in June 1982.

Adult western toads were seen mating through May, and eggs were laid by the end of the month. Thousands of tadpoles hatched from late May to mid-June and congregated along the shoreline.

A great diversity of waterfowl and shore birds use the Kootenay Ponds during migration. Common Loon, Red-necked Grebe and Horned Grebe occur with both species of goldeneye, Bufflehead, White-winged Scoter and Surf Scoter. Some species otherwise rarely seen in the park occurred on Kootenay Pond during spring migration 1983 (Hooded Merganser Ruddy Duck). Dabbling ducks such as Northern Shoveler, Blue-winged Teal, American Wigeon and Mallard were recorded on these ponds during the breeding season. Killdeer nested on the south shore of the main pond. The Spotted Sandpiper, Solitary Sandpiper, Lesser Yellowlegs and Red-necked Phalarope were recorded on migration.

12 SORA POND **(NG672383) elevation: 1214 m.**

Sora Pond is a heavily vegetated marsh. Sedges and cattails are common. Water levels fluctuate with seasonal precipitation.

Three amphibian species occur at Sora Pond. Adult long-toed salamander larvae are abundant in the south marsh from early June to August. Juvenile wood frogs are abundant in the vegetation along the shoreline. The spotted frog has not been detected in the area. Adult and juvenile western toads are common and swarms of tadpoles hatched as early as 21 May in 1982 in the shallow southwest end of the pond.

Several pairs of American Coots nest in the cattails and Soras are presumed to nest as well. Killdeer, Spotted Sandpipers, and Common Snipe are resident during the summer and may breed. Waterfowl are abundant during migration and include Horned Grebes, Pied-billed Grebes, Green-winged Teal, Blue-winged Teal, Mallards, American Wigeon, Buffleheads, Ring-necked Ducks, Barrow's Goldeneyes and Solitary Sandpipers. Red-winged Blackbirds nest in the cattails and at least three species of swallow feed over the surface of the pond.

13. VERMILION CROSSING POND **(NG715531) elevation: 1280 m.**

This small pond is north of Vermilion Crossing adjacent to Highway 93. A small stream flows into the northwest side of the pond and marshy vegetation is found along the opposite shore.

Several hundred western toad tadpoles were found near the stream inlet in shallow water in 1982. By 10 July 1982 they were nearly adult. Adult wood frogs were present in the emergent vegetation.

Mallards, Solitary Sandpipers and Spotted Sandpipers were recorded during migration.

3.6. PELLET GROUP COUNTS AND BROWSE USE SURVEYS.

From 1981 to 1983 ungulate and hare pellets were counted on a total of 849 transects at 286 sites representing 76 Ecosites and 60 vegetation types. Ungulate and hare browse use was assessed on 424 transects (4240 plots) at 212 of the 286 sites. A total of 11,865 plants were assessed. Not all Ecosite-vegetation type combinations were sampled, however extrapolations were made to undersampled Ecosites based on similarities to sampled Ecosites and vegetation types.

Pellet group counts

The number of ungulate pellet groups of each species on each 50 m transect were summed for each Ecosite and vegetation type and converted to pellet groups per hectare by multiplying the total count for each species by the proportion of a hectare sampled: each 50 x 2 m transect sampled 100 m^2 or 0.01 ha. The number of plots on each transect where snowshoe hare pellets were present (see Methods section 2.2.6) were summed for each Ecosite and vegetation type and a frequency (%) calculated by dividing the number of plots with hare pellets in each Ecosite or vegetation type by the total number of plots sampled in each Ecosite or vegetation type.

Table 3.2. Seasonal use of Ecoregions by ungulates and snowshoe hares in KNP based on pellet count transects.

Season*	# transects	Elk	Moose	Deer	Sheep	Goat	Hare pellet frequency (%)
			Ungulate Pellet groups/ha				
Montane							20.8
winter	354	165.8	31.9	109.6	17.7	0.6	
summer	354	39.5	0.6	29.4	0.3	1.1	
Lower Subalpine							25.4
winter	234	35.9	20.1	26.1	0.9	0.9	
summer	234	56.4	3.4	8.5	1.3	0.4	
Upper Subalpine							17.3
winter	223	4.0	2.7	14.3	6.7	29.1	
summer	223	35.9	2.2	4.5	14.8	31.8	
Alpine							0.0
winter	38	0.0	0.0	0.0	21.1	23.7	
summer	38	2.6	0.0	0.0	84.2	81.6	

*winter = mid-July to mid-April; summer = mid-April to mid-July

Table 3.3. Vegetation types with the highest ungulate browse use in KNP from browse use transects.

Vegetation type*	Number of plants	A	B	C	D	E	% ungulate use
			% in hedge class				
C1	557	94.4	3.6	0.7	0.9	0.4	4.4
C5	506	91.3	3.4	2.0	2.2	1.2	6.8
C37	365	94.3	2.2	2.2	0.6	0.8	8.0
C38	957	94.4	3.2	0.8	0.9	0.7	4.7
C39	356	91.6	6.7	0.3	1.4	0.0	4.6
C44	522	91.0	3.4	1.0	4.2	0.6	7.0
H8	67	82.1	13.4	3.0	1.5	0.0	14.4
O6	55	100.0	0.0	0.0	0.0	0.0	5.0
O11	148	89.2	8.8	2.0	0.0	0.0	10.6
O14	98	99.0	1.0	0.0	0.0	0.0	5.1
S1	69	76.8	15.9	2.9	4.3	0.0	9.6
S5	238	94.5	4.6	0.0	1.3	0.0	6.7
S8	151	63.6	22.5	9.9	2.6	1.3	23.0
S16	149	87.2	8.7	0.7	0.7	2.7	6.2

*see Volume I: Achuff and Dudynsky 1984 for descriptions

Table 3.4. Ecosites with the highest ungulate browse use in KNP from browse use transects.

Ecosite*	Number of plants	% in hedge class A	B	C	D	E	% ungulate use
AT4	98	95.9	2.0	0.0	1.0	1.0	6.0
CA1	73	95.9	4.1	0.0	0.0	0.0	15.1
CA2	165	83.6	15.8	0.0	0.6	0.0	9.5
CV1	114	99.1	0.9	0.0	0.0	0.0	5.4
DG1	275	89.5	3.3	3.3	1.8	2.2	10.1
DG3	270	95.6	2.2	0.4	0.4	1.5	5.4
DR2	365	93.2	3.8	1.1	1.6	0.5	5.5
DR8	416	93.3	3.1	0.7	1.4	1.4	4.8
FR3	184	82.1	2.2	4.3	10.3	1.1	7.3
FV5	47	31.9	53.2	10.6	4.3	0.0	32.6
HD3	323	93.8	4.0	0.6	0.9	0.9	5.8
HD6	67	82.1	13.4	3.0	1.5	0.0	14.4
SB1	414	91.3	5.1	2.4	0.7	0.5	5.5
VL2	69	76.8	15.9	2.9	4.3	0.0	9.6
VL6	148	89.2	8.8	2.0	0.0	0.0	10.6

*see Volume I: Walker *et al.* 1984 for descriptions

Ungulate pellet group densities were used as the major indicator of ungulate use of Ecosites and vegetation types. Pellet densities were ranked as low, medium, high or very high for each Ecosite and incorporated into the Master Legend and Ecosite Accounts in Volume I (Walker *et al.* 1984). Densities were also used to assess ungulate habitat selection in terms of Ecosites and vegetation type incorporated into the species accounts in this volume (see Section 5.0). Similarly hare pellet frequencies along with results of winter tracking transects were used to determine Ecosite and vegetation type importance to hares for the Master Legend and Ecosite Accounts in Volume I and the snowshoe hare species account in this volume. Highest winter use by all ungulates except mountain goats is in the Montane Ecoregion (below 1700 m) (Table 3.2). Highest deer pellet group densities year-round are in the Montane Ecoregion. Summer pellet group densities for elk and moose are highest in the Lower Subalpine, but pellets were recorded from the Montane to the Alpine. Summer pellet group densities for bighorn sheep are highest in the Alpine (above 2300 m). Mountain goat pellet group densities are highest in the Upper Subalpine and Alpine Ecoregions. Snowshoe hare pellet frequencies were highest in the Lower Subalpine and Montane Ecoregions, respectively.

Browse Use Surveys

Shrubs are a major forage resource for ungulates year-round, but are browsed most heavily during winter. Heaviest browse use occurred in Montane and Lower Subalpine Ecosites, due to the importance of these areas as ungulate winter range. Of the 16 Ecosites where browsing was heaviest, 10 were Montane and six were Lower Subalpine (Table 3.3). No attempt was made in this study to differentiate the browsing of individual ungulate species. However, based on pellet group densities and random observations, the greatest users of woody browse in the park are elk and moose. There is considerable overlap in Ecosite use by these species (Table 3.2), particularly in the Montane Ecoregion. Because of their greater tolerance of deep snow moose are better able than other ungulates to exploit Lower Subalpine Ecosites in winter.

Using pellet group density as an indicator of relative use of Ecosites by moose and elk, moose browsing was heaviest on Lower Subalpine colluvial (FV5, SB1) and glacial (CA1, CA2) landforms. Important vegetation types include: willow/cinquefoil (S8), willow-dwarf birch-shrubby cinquefoil (S10) and aspen-dwarf

Table 3.5. Ungulate use of selected browse species in KNP, from browse use transects, 1981-1983.

Species	# plants	Freq. (%)	Percentage in hedge class A	B	C	D	E	Total use (%)	Electivity Index*
Montane									
Cornus stolonifera	46	0.9	52.2	34.8	2.2	2.2	8.7	28.7	+0.94
Betula papyrifera	25	0.5	92.0	4.0	0.0	0.0	0.0	8.8	+0.89
Betula glandulosa	37	0.8	89.2	10.8	0.0	0.0	0.0	11.2	+0.87
Salix sp.	165	3.4	53.4	31.6	9.2	5.3	0.7	26.1	+0.77
Menziesia glabella	75	1.5	92.0	1.3	1.3	2.7	2.7	9.1	+0.71
Populus tremuloides	134	2.8	69.4	9.7	3.0	9.7	8.2	16.4	+0.71
Acer glabrum	146	3.0	83.6	6.8	5.5	0.7	3.4	14.2	+0.65
Lonicera involucrata	73	1.5	91.8	1.4	1.4	5.5	0.0	5.8	+0.59
Lonicera utahensis	129	2.7	92.2	4.7	0.0	3.1	0.0	8.9	+0.54
Amelanchier alnifolia	277	5.7	86.6	8.3	4.3	0.7	0.0	12.1	+0.36
Symphoricarpos albus	216	4.4	94.0	1.9	0.0	4.2	0.0	2.2	-0.34
Spiraea lucida	712	14.6	98.2	0.3	0.0	1.5	0.0	1.7	-0.79
Rosa acicularis	993	20.4	98.0	0.6	0.0	0.2	1.2	2.2	-0.81
Shepherdia canadensis	545	11.2	98.5	0.4	0.0	1.1	0.0	1.0	-0.84
Lower Subalpine									
Betula glandulosa	21	0.5	95.2	4.8	0.0	0.0	0.0	5.8	+0.99
Lonicera utahensis	25	0.6	96.0	0.0	0.0	4.0	0.0	11.4	+0.99
Acer glabrum	32	0.7	84.4	6.3	0.0	9.4	0.0	5.2	+0.97
Lonicera involucrata	51	1.2	88.2	9.8	0.0	2.0	0.0	18.4	+0.88
Amelanchier alnifolia	80	1.9	95.0	5.0	0.0	0.0	0.0	5.8	+0.51
Salix sp.	287	6.8	78.5	9.7	8.6	1.5	1.0	19.9	+0.49
Populus tremuloides	51	1.2	92.2	2.0	0.0	5.9	0.0	3.3	+0.47
Ribes spp.	143	3.4	88.8	10.5	0.0	0.7	0.0	6.3	+0.30
Alnus crispa	69	1.7	91.3	7.2	1.4	1.4	0.0	2.1	+0.11
Rubus parviflorus	135	3.2	93.3	1.5	1.5	3.0	0.7	4.0	+0.11
Rhododendron albiflorum	172	4.1	91.9	7.6	0.0	0.6	0.0	4.5	+0.05
Spiraea alba	103	2.5	89.3	10.7	0.0	0.0	0.0	2.7	+0.04
Rosa acicularis	131	3.1	96.2	2.3	0.0	1.5	0.0	1.8	-0.27
Menziesia glabella	614	14.7	89.9	9.0	0.0	1.0	0.2	5.0	-0.49
Shepherdia canadensis	265	6.4	94.0	5.3	0.0	0.8	0.0	1.6	-0.60
Vaccinium membranaceum	292	7.0	98.3	2.1	0.0	0.0	0.0	1.6	-0.63
Upper Subalpine									
Menziesia glabella	50	1.8	94.0	4.0	2.0	0.0	0.0	11.3	+0.72
Salix sp.	264	9.7	90.1	9.9	0.0	0.0	0.0	5.6	-0.27
Rhododendron albiflorum	239	8.7	92.9	7.1	0.0	0.0	0.0	1.7	-0.67
Vaccinium membranaceum	164	6.0	97.6	2.4	0.0	0.0	0.0	1.0	-0.71
Abies lasiocarpa	630	23.1	99.4	0.5	0.0	0.3	0.0	0.0	-1.00
Vaccinium scoparium	771	28.2	100.0	0.0	0.0	0.0	0.0	0.0	-1.00

*after Trottier *et al.* (1983); ranges from -1 (avoidance) to +1 (preference) birch/bearberry (S16) shrub thickets; Engelmann spruce-subalpine fir/false azalea (C14) forest; and spruce/Labrador tea/brown moss (O11) and Engelmann spruce-subalpine fir/rock willow/bracted lousewort (O14) open forest. Other important habitats include the Vermilion Pass burn and Montane alluvial habitats (Tables 3.3, 3.4).

Elk browse use was heaviest in the Montane Ecoregion, particularly on alluvial Ecosites in a variety of vegetation types. Browse probably increases in importance to elk as snow depth increases; elk were observed to stop cratering in open habitats when snow depths exceeded 50 cm. Ungulate browsing was recorded on 49 shrub species. Highly preferred species include ***Acer glabrum***, ***Cornus stolonifera***, ***Betula glandulosa*** and ***Lonicera utahensis***; however, these are of low occurrence and do not contribute significantly to ungulate diets (Table 3.5). Key forage species are those which are common and palatable, rather than rare or highly sought after by ungulates (Telfer 1978, Trottier ***et al.*** 1983).

The distribution of shrubs, in KNP varies with elevation and therefore their importance as ungulate forage varies by Ecoregion.

In the Montane Ecoregion key browse taxa are ***Amelanchier alnifolia***, ***Salix*** sp., ***Acer glabrum***, and ***Populus*** sp.; in the Lower Subalpine key species include ***Menziesia glabella***, ***Salix*** sp., ***Rhododendron albiflorum*** and ***Ribes*** sp.; and in the Upper Subalpine key species are ***Salix*** sp., ***Rhododendron albiflorum*** and ***Menziesia glabella*** (Table 3.5).

The proportion of stems of key browse species in the "C", "D" and "E" hedge (see Methods section 2.2.6) classes is used as an indicator of range condition:

Excellent	0-10%
Good	11-20%
Fair	21-30%
Poor	31-50%
Very Poor	51% +

Stem death or severe reduction in yield of key species as a result of browsing indicates overuse of the range (Cole 1959). Less abundant, but highly preferred species tend to receive disproportionate use and are not good indicators of overall range condition (Trottier ***et al.*** 1983). Based on the above rating scheme for key species, range condition in the Montane is good while in the Lower Subalpine and Upper Subalpine range condition is excellent.

The above analysis provides only a general evaluation of ungulate forage relationships and range conditions in the park. More specific studies are required to adequately assess ungulate dietary relationships and food habits as well as range condition and trend. The reader is referred to Trottier ***et al.*** (1983) for more complete discussions of ungulate range, habitat and foraging relationships.

3.7. HIGHWAY 93 UNGULATE SURVEYS

Between 11 May 1981 and 20 May 1982, 50 weekly road surveys were conducted along Highway 93 (Table 3.6). All the cervids known to occur in the park were observed.

Elk were by far the most common species observed owing to their greater abundance and attraction to the seeded right-of-way for foraging. Use of this man-made grassland area varied between surveys in response to differing weather conditions, and between seasons as a function of the annual migration from winter to summer ranges (Table 3.6). The roadside is used intensively in May as it provides the earliest green vegetation. Elk followed the receding snowline north into the Vermilion valley and dispersed to higher elevations in the Vermilion watershed. Use of the roadsides is least from June through September (Table 3.6). Elk again make extensive use of the roadside during fall and early winter. A rapid southward movement begins in late October and by mid-November most of the elk are south of the Simpson-Vermilion river junction and concentrated in the Wardle Flats (lower Vermilion) and McLeod Meadows (lower Kootenay) areas.

Table 3.6. Maximum semi-monthly counts of elk along Highway 93 in KNP from May 1981 to May 1982

		Distances (km) on Highway 93 from Settlers' Road to Marble Canyon								
Date		0-8	8-17	17-24	24-28	28-38	38-44	44-53	59-62	62-68	Total Elk
May	(E)	23	57	36	0	32	22	15	3	7	195
	(L)	0	5	6	4	19	15	19	16	2	92
June	(E)	0	0	0	0	0	2	3	5	16	26
	(L)	0	0	0	0	1	25	3	3	4	36
July	(E)	0	0	0	0	0	8	6	10	7	31
	(L)	0	0	0	0	0	0	9	17	4	30
August	(E)	0	0	0	0	0	0	0	1	2	3
	(L)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
September	(E)	0	0	0	0	1	0	3	2	0	6
	(L)	1	0	0	0	0	1	0	0	0	2
October	(E)	0	0	0	0	6	12	6	14	5	50
	(L)	0	14	4	0	46	23	7	33	4	135
November	(E)	0	2	14	0	24	4	2	22	2	70
	(L)	38	136		0	13	0	0	0	25	266
December	(E)	82	30	45	0	25	0	0	0	0	182
	(L)	113	3	20	0	8	0	0	0	0	153
January	(E)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
	(L)	8	1	2	0	0	0	0	0	0	11
February	(E)	0	15	5	1	0	0	0	0	0	21
	(L)	4	13	0	0	6	0	0	0	0	23
March	(E)	1	0	0	0	230	0	0	0	0	241
	(L)	27	13	0	0	11	0	0	0	0	51
April	(E)	0	0	0	0	3	0	0	0	0	3
	(L)	35	31	2	11	4	0	0	0	0	83
May	(E)	62	64	13	5	20	0	0	0	0	164
	(L)	41	48	22	11	35	5	3	0	0	165

E = 1st to 15th of month
L = 16th to end of month

A small band of 25-30 elk remained in the Marble Canyon area in November and December 1981 and are thought to have moved over the Vermilion Pass to winter in the Bow valley of Banff National Park. Intensive use of the road allowance for foraging continued into mid-December although the highest count of elk (266) was on November 27 (Table 3.6).

Elk observations along the highway decreased in late December and early January, corresponding to the time when average snow depths exceeded 50 cm. Snow measurements taken at 5 km intervals along Highway 93 between Settler's Road and the Simpson River on 29 January 1982 averaged 59.3 cm with a range of 42.3 cm (Wardle flats) to 73.3 cm (Settler's Road). Use of roadsides and other open habitats along the Kootenay River remained low until late April when the snowpack began to shrink. Snow depth measurements were taken again on 19 April 1982 from Settler's Road to Marble Canyon. Snow depths along the roadside averaged 32.1 cm from Settler's Road to Wardle Creek with a range of 8 cm (Wardle flats) to 60 cm (Settler's Road), and 87.9 cm from Simpson River to Marble Canyon with a range of 35 cm (Simpson River) to 130 cm at Numa Creek. Snow cover was continuous along the route except for the Hector Gorge area (75% cover) and Wardle flats (60% cover). Throughout the winter snow depths were consistently lowest between McLeod Meadows and Dolly Varden Cr. and on Wardle flats. These were also the areas of highest winter elk activity.

Although Highway 93 is a major source of elk mortality, particularly in recent years (Sheehan 1982)it is an important source of forage for elk in spring, autumn and early winter. Elk use of these habitats is correlated to snow depth which varies from year to year. Winters with early high snowfalls or early crusting conditions will prevent elk from exploiting meadow areas and force them into less favorable forested habitats.

White-tailed deer were the second most frequently observed ungulate along the highway corridor (Table 3.7). Cowan (1943) suggested that summer range for whitetails was restricted to riparian habitats along the river courses. The alignment of the highway places it right through these major summering areas. Mule deer, which are seen less frequently along the highway, tend to summer at higher elevations.

There appears to be a northward movement of whitetails in the Kootenay valley during late spring and early summer with a few animals occupying the Vermilion valley. Most were seen during the summer months in the Kootenay valley from Settler's Road to Kootenay Crossing (Table 3.7). There was a rapid decline in observations in early autumn and the last sightings were on 29 October 1981. Whitetails apparently move south in the Kootenay valley and west into the Columbia valley during the winter months (Cowan 1943, park wildlife cards). Whitetails were first seen in spring on 20 May 1982 near Kootenay Crossing.

Mule deer were not common along the roadside: there were seven observations of eleven animals (2 males, 5 females, 4 yearlings) from 10 June to 26 July and five observations of eight animals (1 male, 4 females, 3 yearlings) from 17 September to 26 November. Most of the summer observations were from the Hector Gorge to Hawk Creek (lower Vermilion) area with only two observations from the McLeod Meadows area. All of the autumn observations were in the lower Kootenay valley between McLeod Meadows and the Kootenay Viewpoint. Earlier records indicate that mule deer leave the Kootenay and Vermilion valleys to winter in Sinclair Canyon and west into the Columbia valley (Cowan 1943, Munro and Cowan 1944, park wildlife cards).

Moose were seen infrequently during road surveys and all but two of the observations were made during June and July, 1981. Most of the observations were associated with two licks: one on the roadside between Settler's Road and Nixon Creek and the other on the roadside between Wardle Creek and the Simpson-Vermilion River junction. Three individual moose, (male, female and yearling) were observed on two surveys in the Settler's Road - Nixon Creek area and two individuals (female and yearling) were seen on four seperate surveys near the lick between Wardle Creek and Simpson River. A male and a female were observed on five separate surveys in the Numa Creek-Marble Canyon section of the upper Vermilion River valley.

All observations from road surveys were coded on Mountain Parks Wildlife Ground Survey Data Forms (GPI6) and are in the KNP wildlife file of the Canadian Soil Institute (CANSIS) computer system.

To assess habitat selection by elk and white-tailed deer during peak periods of use, the total animals observed during road surveys was compared to the relative availability of Ecosites along the highway corridor from Settler's Road (km 0) to Wardle Creek (km 36). Relative availability of Ecosites along the route is expressed as a percent occurrence of an Ecosite based on the linear distance of the highway through each Ecosite. The distance through each Ecosite was measured from the 1:66,000 mapped air photos and converted to kilometers. The kilometer values of each Ecosite or combination of Ecosites through which the highway passes were summed for each Ecosite and converted to a percentage. The percent occurrence of Ecosites was compared to the percent of total animal observations in each Ecosite using an electivity index method (Trottier *et al.* 1983) (Table 3.8).

During autumn and early winter elk actively seek-out alluvial fans (FR1, FR3) and glaciofluvial terraces (AT1, AT4) with spruce-aspen-lodgepole pine (paper birch)/buffaloberry/pine grass (C44), white spruce-Douglas fir/feathermoss (C5) and lodgepole pine/buffaloberry/pine grass (C38) forest. Combinations of Ecosites are more preferred than individual Ecosites (eg. FR3/AT4 and FR1/AT1). Single Ecosites dominated by lodgepole pine forest (C38, C39) are avoided while combinations of alluvial and morainal landforms with lodgepole pine vegetation types are used roughly in proportion to their availability (Table 3.8). During this period elk foraging is concentrated on the seeded highway right-of-way and in small grassy meadows (VL2) and active floodplain (HD6) areas adjacent to the highway and lower Kootenay and Vermilion rivers. Adjacent forest is primarily used as cover for bedding.

Key areas of elk concentration along the highway corridor during autumn and early winter include Nixon Creek fan, Meadow Creek fan, Crook's Meadow, Kootenay Crossing meadows and Wardle flats.

Whitetails are less numerous than elk and therefore provided a much smaller sample size. They were not observed in all Ecosites or Ecosite combinations available along the highway corridor.

Table 3.7. Cumulative counts of white-tailed deer seen on roadside surveys from May 1981 to May 1982 along Highway 93 in KNP.

Date	Distances (km) on Highway 93 from Settler's Road to Marble Canyon									
	0-8	8-17	17-24	24-28	28-38	38-44	44-53	53-62	62-68	Total
May	12	2	3	0	2	0	0	0	5	24
June	4	5	6	1	1	1	2	0	0	20
July	5	1	0	1	0	0	0	0	1	8
September	0	0	0	0	0	2	0	0	0	2
October	0	2	0	0	0	0	1	0	0	3
May	0	0	2	0	0	0	0	0	0	2

Table 3.8. Ecosite selection by elk and white-tailed deer along Highway 93 from Settler's Road to Wardle Creek, October to December 1981, from roadside ungulate surveys.

Ecosite	Predominant vegetation	Percentage of Ecosite along highway	Number seen	(% of total)	Electivity Index*
Elk					
FR3	mixedwood	6.6	284	(25.3)	+0.59
FR3/AT4	mixedwood/spruce	8.5	238	(21.1)	+0.43
FR1/AT1	lodgepole pine	2.8	78	(6.9)	+0.42
AT4	spruce forest	16.6	181	(16.2)	-0.01
DR7/AT1	lodgepole pine	14.2	142	(12.6)	-0.06
FR1/DR7	lodgepole pine	5.7	15	(1.3)	-0.06
DR2/DR8	lodgepole pine	2.8	29	(2.5)	-0.06
AT1	lodgepole pine	10.0	38	(3.3)	-0.50
DR7	lodgepole pine	15.7	43	(3.8)	-0.61
DR5	spruce/Douglas fir	7.1	10	(0.8)	-0.79
DR6	spruce/mixedwood	2.8	2	(0.1)	-0.90
White-tailed deer					
FR1	lodgepole pine	6.6	16	(42.1)	+0.73
DR2/DR8	lodgepole pine	2.8	4	(10.5)	+0.58
FR3/AT4	mixedwood/spruce	8.5	8	(21.0)	+0.42
AT1	lodgepole pine	10.0	4	(10.5)	+0.02
DR7/AT1	lodgepole pine	14.2	3	(7.8)	-0.29
FR3	mixedwood	6.6	1	(2.1)	-0.52
DR5	spruce/Douglas fir	7.1	1	(2.1)	-0.54
AT4	spruce forest	16.6	1	(2.1)	-0.78

*Electivity index after Trottier *et al.* (1983): ranges from +1 (preference) to -1 (avoidance);
Where two Ecosites are separated by a slash, it represents areas where they both occur on opposite sides of the highway.

In contrast to elk, whitetails forage at the forest edges rather than in the open grasslands and meadows. Greatest preference was shown for lodgepole pine dominated alluvial (FR1, AT1) and morainal (DR2, DR8) Ecosites and combinations of alluvial landforms with spruce-aspen-lodgepole pine (paper birch)/buffaloberry/pine grass (C44) and white spruce/buffaloberry/feathermoss (C37) closed forests. Combinations of Ecosites are preferred over single Ecosites, perhaps because of the greater amount of habitat edge available. Key areas along the highway corridor for whitetails are: the FR1 and DR2/DR8 units at Settler's Road and Nixon Creek, FR3/AT4 between Crook's Meadow and Dolly Varden Creek and AT1 from Dolly Varden Creek to Kootenay Crossing.

3.8. MT. WARDLE GOAT SURVEYS

The population of mountain goats on Mt. Wardle numbers 60 to 70 animals (Table 3.9). The highest count during 1981 was on 5 October when 33 were observed. Unfortunately, surveys were begun too late in 1981 for good counts of young-of-the-year but a pre-kidding count of 53 was obtained by Warden Enderwick in April 1981(park wildlife cards), which, with the addition of the maximum number of kids observed on 5 October, places the summer 1981 population at a minimum of 59 animals and a ratio of 11.3 kids/100 adults. A slightly lower pre-kidding population was recorded in 1982: 42 goats were counted on the winter range on 13 May 1982. This suggests a possible higher winter mortality during winter 1981-82 than the previous winter. Weather records from nearby Kootenay Crossing warden station show that the winter of 1981-82 was more severe (colder temperatures and higher snowfall) than the winter of 1980-81. Kid production during 1982 was more than double that recorded in 1981. A maximum count of 16 kids in June 1982, added to the pre-kidding count of 42, gives a minimum population of 58 and a ratio of 37.2 kids/100 adults. The highest count for summer 1982 was 59 on 7 July 1982. Therefore, even though productivity varied considerably between the two years of study, the total population remained constant at an estimated 60 to 70 goats. Mean productivity values (kids/100 adults) of mountain goats in other studies (Table 3.10) shows that the productivity of the Mt. Wardle herd was below normal in 1981 and above normal in 1982.

Mean monthly group size ranged from 1.6 to 9.6 with largest group sizes during summer (5.2) and the smallest during autumn (2.7). Actual group sizes varied from 2 to 27 with an overall mean of 3.9. As noted in this study and by Holroyd (1967) and DeBock (1970) goats are only loosely gregarious and the size and composition of groups changes daily and even hourly. Goats were observed singly or in pairs in 73.5% of sightings (Table 3.12). The most common association was a female and young-of-the-year. Adult males are solitary or in pairs and live apart from other age and sex classes for all but the rut period. Females with young are often in groups of four to ten, except during bedding time when females are usually solitary. Some of the largest groups of mixed age/sex classes are at licks during summer.

Certain slope aspects within the study area (west through north-facing slopes) were not visible from the highway and could not be included in the analysis of seasonal use by aspect (Table 3.13). This bias is most significant during summer and autumn (August to October) when goats range west and north onto the southern portions of the Vermilion Range and are not visible from the highway.

There was a strong difference in selection of aspect between winter and summer (Table 3.13). During winter over 90% of the goats observed were on south- to east-facing slopes and 69% were concentrated on the south-facing aspect. No goats were observed on the southwest aspect during winter. By contrast, during summer and early autumn 69 to 86% of goats observed were on the southwest aspect and less than 20% were observed on the south aspect. No goats were observed on eastern aspects during summer and autumn. These observations support the conclusions of earlier investigations (Holroyd 1967, DeBock 1970) that there is a definite separation between summer and winter ranges on this mountain.

During spring (March, April, May) the goats were observed on all aspects with increased use of the southwest aspect during late spring being a function of time of snow melt and forage availability. Various aspects are selected during spring by different segments of the population. Pregnant females and yearlings move onto the southeast and east aspects in April and May, these being the main kidding areas. The adult male and subadult male and non-breeding female cohorts begin moving onto summer ranges during April and May. McFetridge (1977) described a similar divergence in habitat use and resource strategy by different cohorts of a goat population in west central Alberta.

Table 3.9. Mountain goat survey counts on Mt. Wardle, July 1981 - January 1983.

Date	Total	U/C Ads.	M	F	YOY	YLY	YOY /100 ads.	YLY /100 ads.
1981								
26 July	5		1	3	1		25.0	
04 Aug	0							
05 Oct	33	21		6	6		22.2	
15 Oct	32	27			5		18.5	
23 Oct	9	9						
04 Nov	21	20	1					
16 Dec	17	15			2		13.3	
1982								
20 Jan	18	8		6		4		28.6
09 Feb	4	4						
12 Feb	15	14				1		7.1
22 Feb	42							
25 Feb	13	11				2		18.2
05 March	4	4						
15 March	20							
29 March	0							
15 April	41							
30 April	15							
13 May	42	35		5		2		5.0
31 May	41							
26 June	54	13	3	18	16	4	47.1	11.8
07 July	59	45			14		31.1	
10 July	41	1	4	21	11	4	42.3	15.4
24 July	37	27			10		37.0	
28 Aug	1	1						
17 Sept	11	8			3		37.5	
30 Sept	20	15			5		33.3	
25 Oct	20	24			5		20.8	
08 Nov	26	21			5		23.8	
1983								
13 Jan	39	14	3	11		11		39.3

The Mt. Wardle goat population may be somewhat atypical in its choice of different aspects between summer and winter. McCrory *et al.* (1977; 1978) indicated that, on a whole, goats in Yoho National Park did not show strong seasonal preferences for various aspects.

Goats were observed at the lowest elevations during winter (95% between 1372 and 1676 m.) and moved progressively upward until fall when more than 70% were observed above 1828 m. (Table 3.14). The low elevation observations during summer (1219 m.) were primarily from the licks at the base of the southwest aspect (Figure 2.5). Similar trends in seasonal elevation use were described by McCrory *et al.* (1977) for goats in Yoho National Park and by McFetridge (1977) for goats in west central Alberta. Holroyd (1967) and DeBock (1970) reported similar seasonal elevation changes for the Mt. Wardle population.

In winter goats were observed most frequently on Montane colluvial Ecosites on the south aspect above Highway 93 and the Vermilion River (Figure 3.13). Most heavily used of these Ecosites was DG3 (65.7% of 131 observations). Feeding activity was most associated with aspen-shrub (C22), avalanche shrub (S16) and open coniferous forest (O5) in close proximity to rocky outcrops(Figure 2.3). Goats always bedded on rock outcrops and cliffs. In spring there was a progressive movement to higher elevations apparently related to snow melt. As mentioned in the previous section pregnant females remained on the south and southeast facing DG3

Table 3.10. Estimates of productivity of goat populations in the Rocky Mountains.

Area	Years	Kids/100 adults*	Reference
Mt. Wardle, KNP	1951-1980	27.5	Park Wildlife Observations
Mt. Wardle, KNP	1962-1963	33.7	Holroyd, 1967
Alberta	1973-1976	30	Hall, 1977
Smoky River, Alberta	1974-1975	29	McFetridge, 1977
Yoho National Park	1975-1976	29	McCrory *et al.* 1977
Mt. Wilson, BNP	1978-1979	14	Holroyd and Van Tighem, 1983
Mt. Kerkeslin, JNP	1978-1979	23	Holroyd and Van Tighem, 1983

*"Adults" includes yearlings.

and SB4 Ecosites(Figure 2.4) while adult male and non-breeding female-yearling groups moved westward and upward following the receding snowline onto the DG3, SB4 and lower WF2 Ecosite on the southwest face. Pregnant females remained in the rugged cliffs on the eastern portion of the winter range until one to two weeks after kidding when they began moving westward to the southwest face.

By mid-June the nursery groups were making almost daily trips from the DG3 and SB4 Ecosites on the southwest face to the licks at the base of this aspect above Highway 93. Adult male and non-breeding female-yearling groups made less frequent use of these licks. Heavy use of the licks continued until late July when most goats had moved to the Upper Subalpine and Alpine Ecoregions, on southwest aspects. Goats were most frequently observed on the WH4 and BS1 Ecosites and by mid-August many had moved northward out of sight. During summer goats fed mainly in BS1, WF2 and SB4 Ecosites and bedded most frequently on the steep, rocky slopes of the WH4 and SB4 Ecosites or in krummholz on the WF2 Ecosite(Figure 2.5).

During September few goats were seen on the southwest face. In early October they began returning to this area and were dispersed throughout the FV4, WH4, WF2 and BS1 Ecosites, tending to forage at greater distances from rocky terrain than at any other season. Increasing snow depths at higher elevations in the autumn and early winter forced the goats back onto the lower Subalpine and Montane SB4 and DG3 Ecosites. By late December all the goats had returned to the rocky, south-facing winter range.

The variability in goat counts between surveys and seasons is caused by:

seasonal movements
weather
time of day
observer experience and
count duration or methodology

Counts are affected by seasonal movements of the goats between winter and summer ranges. These movements have been well documented by both Holroyd (1967) and DeBock (1970) and are discussed in the mountain goat species account. Maximum pre-kidding counts are during April and May while post-kidding surveys are best done between mid-June and mid-July. Owing to the protracted nature of the movement from summer ranges back to the winter range, autumn surveys, at least on this range, are rarely useful.

As was found in this study and by DeBock (1970) goats are little affected by weather conditions except for extremes of storm, cold or heat. It appeared during our study that counts were higher on clear, sunny days than on days with heavy cloud cover. This is due as much to improved visibility on sunny days as

Table 3.11. Mean group sizes of mountain goat on Mt. Wardle by month, 1981-1982.

Month	number of groups	mean group size	seasonal mean
January	14	4.2	
February	27	3.0	3.8
March	5	4.8	
April	34	1.6	
May	30	2.7	3.1
June	11	4.9	
July	10	9.6	5.2
September	12	2.6	
October	33	3.1	
November	26	1.9	2.7
Overall mean		3.9	

Table 3.12. Frequency of group sizes of mountain goats on Mt. Wardle, 1981-1982.

Group size	# of records	Frequency (%)
1	84	40.4
2	48	23.1
3	27	12.9
4	17	8.2
5	7	3.4
6-10	17	8.2
11-15	4	1.9
16-20	1	0.5
21+	3	1.4

it is due to behavioural changes. Goats appear to respond to early morning sunshine by coming to exposed ledges and rock faces. Light conditions are particularly important during winter surveys as flat light makes goats very difficult to see against the snow.

The experience of observers and consistency in methodology are the keys to success of any scientific survey and surveys of mountain goat are no exception. The observer must be familiar with the diurnal and seasonal movements of the goats, the topographic and vegetational features of the summer and winter ranges which affect goat distribution, the responses of goats to weather variables and the criteria for age and sex classification. A consistent approach in methodology both between counts and between years is paramount in maintaining continuity and minimizing bias.

Table 3.13. Seasonal use by mountain goats of various slope aspects on Mt. Wardle, 1981-1982.

	% of goats observed			
Aspect	WINTER (111)*	SPRING (152)	SUMMER (191)	AUTUMN (164)
Southwest	0	40	69	86
South	69	23	19	14
Southeast	12	17	0	0
East	10	18	0	0
Lick	9	2	12	0

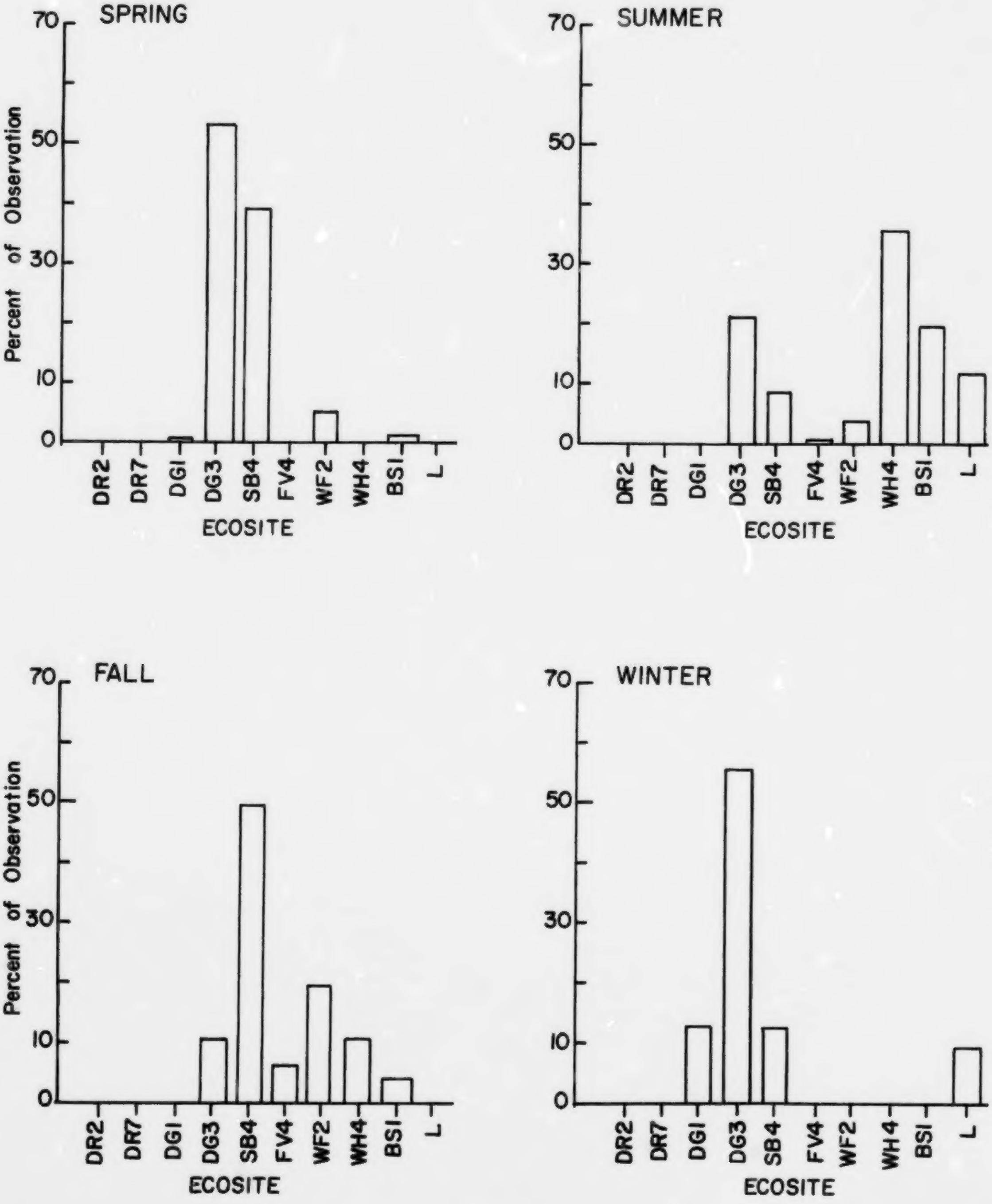
*total goats observed.

Table 3.14. Seasonal use by mountain goats of various elevation ranges on Mt. Wardle, 1981-1982.

	% of goats observed			
Elevation m(ft)	WINTER	SPRING	SUMMER	AUTUMN
1219(4000)	11	11	13	6
1372(4500)	5	32	15	6
1524(5000)	75	14	1	3
1676(5500)	45	34	7	13.5
1828(6000)	0	2	0	30.5
1981(6500)	0	6	32	22
2133(7000)	4.5	1	7	16
2286(7500)	0	0	25	2.5
2438(8000)+	0	0	0	0.5

One major drawback to this survey method is the inability to obtain accurate herd composition information due to the great observation distance. Observation distances ranged from two to three kms. on the summer range to one-half to one km. on the winter range. At these distances it is only possible to separate animals older than one year from the young-of-the-year age class. This can be converted to an adult:young (or young/100 adults) ratio which is the most common indicator of goat productivity found in the literature. The most complete compositional information can be obtained during June and July when large numbers of goats frequent the lick areas adjacent to the highway. Here observations are at close range and accurate age-sex classification is possible. Herd composition from such counts will be biased towards the female and young age-sex classes as the adult males frequent the licks less often.

Figure 3.13. Seasonal Ecosite use by mountain goats on Mount Wardle.



3.9. SINCLAIR-STODDART CREEKS SHEEP SURVEYS

Between October 1981 and May 1983 a total of 28 sheep surveys were conducted in the Sinclair Creek to Stoddart Creek area of KNP. Sheep utilize these low elevation Montane colluvial slopes and glacial terraces most frequently during spring, autumn and winter and large composition count samples can be obtained. During summer they frequent Upper Subalpine and Alpine ranges in the Mt. Berland-Mt. Kindersley and Mt. Sinclair areas and are less easily surveyed.

Counts were done oportunistically whenever weather conditions were optimum and large groups of sheep were available. Surveys were closely coordinated to periodic surveys conducted by the Warden Service. All survey results as well as random observations were coded on Mountain Parks Wildlife Survey Data Forms (MPI6) and stored in the CANSIS computer facility in Ottawa.

The seasonal distribution, herd composition and productivity information provided by these counts was analysed with data from pellet group counts, browse use plots and winter track transects and incorporated into the discussion of bighorn sheep seasonal distribution and range (Ecosite) use, and population dynamics in the bighorn sheep Species Account (section 4.).

3.10. WINTER TRACK COUNT TRANSECTS

During the winters of 1981-82 and 1982-83, 236 winter track count transects were conducted, representing 315.4 km-days of track counts (Table 3.15). The track count season extended from late November to early April at high elevations, but most transects were sampled from December to March. All Ecosites were not sampled equally, rather they were sampled in proportion to their areal extent and accessibility. Thus Upper Subalpine and Alpine colluvial Ecosites were undersampled due to inaccessibility or high avalanche hazard.

Densities were calculated as tracks per km-day by Ecosite. Ecosites were ranked in order of increasing track count densities for each species. The Ecosites in the lowest third of this range were considered of low importance to the species, and those in the upper third were considered of high importance. Exceptionally high densities on one or two Ecosites were considered as very highly important. These rankings were used in the Map Supplement and Ecosite accounts (see Walker *et al.* 1984). Track count densities were also incorporated into the Species Accounts (section 4) as measures of seasonal distribution and winter habitat use. A summary of track count results by species is in Table 3.16.

3.11. SMALL MAMMAL TRAPPING

Snap Trapping

A total of 956 small mammals was captured (Table 3.17) on 50 snap trap lines from 1981 to 1983. Trapping began as early as 24 July 1983 and ended as late as 3 November in 1981 and 1982. Twelve small mammal species were considered to be accurately sampled by snap trapping. Two species (red squirrel and northern flying squirrel) are only rarely captured in Museum Special snap traps and their importance ratings were not based on snap trapping data. No samples were taken from the Alpine Ecoregion and not all Ecosites were sampled. For importance ratings in the wildlife legend for Ecosites that were not sampled, the species composition was estimated using the species composition of the v.t's known to occur in the Ecosite.

Table 3.15. Number of winter track-count transects in KNP by Ecoregion

Ecoregion	# of transects	# of km-days
Alpine	-	
Upper Subalpine	31	30.9
Lower Subalpine	69	108.8
Montane	136	175.7
Total:	236	315.4

Table 3.16 Winter tracking results in KNP by species

Species	# of transects	# of tracks	Tracks per km-day
snowshoe hare	129	1251	3.9
red squirrel	129	885	2.8
marten	125	494	1.6
weasel	74	231	0.7
coyote	48	183	0.6
elk	45	328	1.0
moose	33	83	0.3
lynx	31	40	0.1
wolf	12	36	0.1
wolverine	11	26	0.08
deer mouse	10	28	0.09
porcupine	9	15	0.15
bighorn sheep	7	57	0.18
mule deer	4	23	0.07

Live Trapping

Two small mammal live-trapping plots were set out: one in the Montane and one in the Lower Subalpine. The first plot (Redstreak) was in Douglas fir open forest (WY1; C1) on 6 July 1981 for 5 nights and 13 October 1982 for 6 nights. The second (Verendrye Creek) was in spruce-subalpine fir forest (AT1; C14) on 24 August 1982 for 7 nights. Deer mice were the only common small mammals on the Redstreak plot and Gapper's red-backed voles were the only common small mammals on the Verendrye Creek plot. (Table 3.18). The density of deer mice on the Redstreak plot was about half-as-much in 1982 as in 1981 but no reason for this was evident. The density of Gapper's red-backed vole on the Verendrye plot was much higher than any other small mammal species.

Table 3.17. Small mammals caught in snap trapping in KNP, 1981-1983, presented by Ecoregion.

Species		*Ecoregion*		*Total*
	Montane	L.Subalpine	U.Subalpine	
Dusky shrew	6	3	6	15
Pygmy shrew	1	0	0	1
Masked shrew	6	2	1	9
Shew (unid.)	2	0	1	3
Least chipmunk	0	1	1	2
Yellow-pine chipmunk	6	3	0	9
Northern flying squirrel	1	0	0	1
Red squirrel	0	1	0	1
Deer mouse	88	18	0	106
Northern bog lemming	3	1	0	4
Heather vole	1	4	7	12
Gapper's red-backed vole	446	162	92	700
Meadow vole	46	6	0	52
Long-tailed vole	20	3	6	29
Western jumping mouse	11	0	1	12
Total	636	204	115	956
Number of trap lines	31	9	10	50

Table 3.18. Minimum number of small mammals known alive on two live-trap plots in KNP.

Species	*Live Trap Plot**		
		Redstreak	*Verendrye Creek*
	1981	1982	1982
Deer mouse	33 (24.8 per ha)	18 (13.5 per ha)	
Gapper's red-backed vole	-	1	71 (52.9 per ha)
Heather vole	-	-	1
Shrew spp.	-	-	1
Dusky shrew	-	-	1

*Locations of plots are described in text.

3.12. BAT SURVEYS

Extensive surveys for bats were conducted in KNP during July 1981 and the results are published elsewhere (Fenton *et al.* 1983). Supplementary monitoring by wildlife inventory staff provided information on arrival and departure dates and some added information on distribution and activity of bats known to inhabit

KNP.

1981
Autumn: Bats were feeding by the street lights along Highway 93 from Westgate west along the Sinclair Canyon, as late as 6 October. All calls registered at a frequency of 40 khz, and were probably species of ***Myotis***. Insects were observed at all three lights that were sampled.

1983
Spring: Bats were active along the shore of Lake Windermere on 2 May, but were not detected in KNP during spring owl surveys until 9 May. The temperature was 10°C on a clear, windless night at the time of the first bat observation.
1983
Spring: On 28 April bats were present in the Columbia valley but absent in KNP. On 3 May, a group of hoary bats was present along the Sinclair Canyon from West Gate to Radium. They were feeding above the canyon in the Douglas fir forest and above Highway 93 but did not seem to be attracted to the lights. Activity was high, above 5.6 passes/min at 2230. By May the temperature had dropped and there was no bat activity at this location. By 12 May little brown bats were present in Sinclair Canyon. Bat activity was low (0.8 passes/min).

3.13. RIVER SURVEYS

The lower Kootenay River was surveyed by kayak on 13 June 1982 from McLeod Meadows (NG752240) to the Settler's Road bridge on the south boundary (NG850075). Spotted Sandpipers were common along the entire length of the river. Eastern Kingbirds were seen on regenerating spruce along riverbank by the Conservation Corps. bridge. Several Belted Kingfishers were observed and a pair of Canada Geese were seen in a backwater slough above the Cross River. An abandoned beaver site was discovered on another backwater slough near the south boundary. Several dams were in disrepair and lodgepole pine and other unpalatable tree species had been felled.

4. SPECIES ACCOUNTS

All available information on wildlife species recorded in KNP is summarized below. Habitat information is based on data collected during this inventory. Ecosite and vegetation type abbreviations refer to detailed descriptions in Volume I (Achuff *et al.* eds. 1984). Volume I also contains descriptions of small mammal associations, breeding bird communities, and wildlife use of Ecosites; all of these provide further information on the species discussed below.

4.1. AMPHIBIANS

Of 20 amphibian species that occur in British Columbia, 4 breed in KNP. The three ponds in the vicinity of Kootenay Crossing are important to three species of amphibians as breeding sites in early spring. Nomenclature follows that of Behler and King (1979).

WOOD FROG ***Rana sylvatica*** **WOFR**

STATUS AND DISTRIBUTION

The wood frog ranges across Canada. It occurs throughout most of B.C., except the southwestern corner (Behler and King 1979).

The wood frog has a more widespread distribution than the spotted frog in KNP. It occurs in most ponds and wetlands of the Kootenay valley and lower Vermilion valley. Eggs were discovered in Kootenay Pond, and juveniles indicate possible breeding sites at Nixon Lake, Dog Lake, Daer Pond, Sundew Pond, and Sora Pond.

HABITAT

The wood frog occurs in ponds and wetlands of the Montane and Lower Subalpine Ecoregions.

SPOTTED FROG ***Rana pretiosa*** **SPFR**

STATUS AND DISTRIBUTION

The spotted frog occurs in western Canada from Bennett Reservoir on the Yukon border, throughout B.C. to the Rocky Mountains (Carl 1943).

In KNP, spotted frogs breed in ponds of the lower Kootenay valley, including Dog Lake, Nixon Lake, and Cobb Lake. There is one observation of an adult from Kootenay Pond, but they are not known to breed there. There is one record for Ottertail Pass, at an elevation of 1980 m.

HABITAT

The spotted frog occurs in ponds, wetlands and along streams of the Montane, and rarely, Upper Subalpine Ecoregions.

SPECIES ATTRIBUTES

Spotted frogs breed immediately after spring break-up; eggs are laid earlier than those of other amphibians in KNP. Tadpoles were seen at Dog Lake as early as 26 May 1981. They were in deeper water than western toad tadpoles inhabiting the same area.

WESTERN TOAD *Bufo boreas* NOTO

STATUS AND DISTRIBUTION

The western toad occurs in western Canada from the Pacific coast east through the Rocky Mountains of Alberta. In B.C. it occurs across the province north to the Peace River district and the Alaska border (Behler and King 1979).

The western toad has the widest distribution of the amphibians of KNP. It occurs in all major watersheds from valley bottom to 2000 m. Most of the ponds in the Kootenay valley are used for breeding. Many small ponds and temporary pools of water along the Vermilion River contain swarms of developing larvae during summer.

HABITAT

The western toad breeds in shallow waters of ponds and almost any available body of fresh water in the Montane and Lower Subalpine Ecoregions. Adults disperse after breeding and may occur along forested trails and in wet shrublands, avalanche slopes and subalpine meadows.

SPECIES ATTRIBUTES

Mating and egg laying occur later in the breeding season than the other species of amphibians. Tadpoles tend to congregate in warm shallow water along the shoreline of ponds, especially those that are free of vegetation. Metamorphosis occurs quickly, and young toads emerge by mid-August. In 1982 many ponds used by breeding toads had dried up by late August (Table 4.1).

LONG-TOED SALAMANDER *Ambystoma macrodactylum* LOSA

STATUS AND DISTRIBUTION

The long-toed salamander occurs in western Canada from south-central B.C. to the Rocky Mountains, and along the coast to Alaska (Behler and King 1979).

The first record of a long-toed salamander in KNP was in October 1963 near the Administration building (park wildlife cards). The species breeds at the Kootenay Ponds, Sora Pond, and Nixon Lake. Adults disperse after breeding, and their distribution is not known.

Table 4.1. Western toad phenology in Kootenay National Park, 1981-1982

Location	First seen	First mating	First eggs	First larvae
1981				
Kootenay Pond	May 21	May 21	May 21	May 26
Sora Pond	May 21	-	-	May 21
Dog Lake	-	-	May 26	May 26
1982				
Kootenay Pond	-	-	May 30	
Kootenay Pond #2	May 20	May 20	-	
Sora Pond	-	-	-	June 2
Dog Lake	-	-	June 3	June 3

Table 4.2. Long-toed salamander phenology in Kootenay National Park, 1982-1983

Location	First seen	First mating	First eggs	First larvae
1982				
Kootenay Pond	May 20	-	-	July 9
Sora Pond	May 20	-	-	
Nixon Lake	-	-	May 31	June 2
1983				
Kootenay Pond	April 28	May 2	May 10	
Kootenay Pond #2	May 10	-	May 10	
Nixon Lake	Jan 28	-	May 17	

HABITAT

In early spring, adult long-toed salamanders are found under rocks and logs along the shorelines of ponds in the Montane Ecoregion. They occur underground or in forest litter during the rest of the year. Larvae develop in small, shallow ponds in areas with vegetation. In Sora Pond they are commonest in emergent sedges at the shallow south end. A limited amount of aquatic vegetation is available along the south and west shore of Kootenay Pond, where larvae are found.

SPECIES ATTRIBUTES

Adult long-toed salamanders arrive at their breeding sites in late April immediately after spring breakup. In 1982 adults peaked in numbers by 20 May and had left the breeding areas by early June (Table 4.2).

In 1982, eggs were laid by 10 May, and hatched by the end of May. Larvae develop over the summer in Sora Pond and were nearly mature by late August. Long-toed salamander larvae were discovered in the open springs at the north end of Nixon Lake in January 1983 (LRH).

4.2. REPTILES

The only reptiles recorded in KNP are three species of snake, one of which is considered hypothetical. Snake populations are small, localized, and vulnerable to disturbance. Nomenclature follows that of Behler and King (1979).

WESTERN TERRESTRIAL (WANDERING) GARTER SNAKE *Thamnophis elegans vagrans* WASN

STATUS AND DISTRIBUTION

The wandering garter snake inhabits western Canada from south-central B.C. to southwestern Saskatchewan (Behler and King 1979).

In KNP, the wandering garter snake is found in the Sinclair Canyon on rocky outcrops and on grassy areas created by human disturbance. There is a single record for Mt. Wardle south of Wardle Creek, near the grassy road verge.

HABITAT

The wandering garter snake inhabits dry rocky bluffs and dry creekbeds in the Montane Ecoregion. Most records are from WY1 in open Douglas fir forest and grassy areas. There is one record from open, dry aspen forest at the base of an avalanche slope.

SPECIES ATTRIBUTES

The earliest spring record is on 9 May 1983 at the Sinclair Warden Station adjacent to the McKay Cr. Compound. By 14 May a total of 14 snakes were found at this location (BRS). A snake hibernaculum probably exists in this vicinity.

COMMON (RED-SIDED) GARTER SNAKE *Thamnophis sirtalis parietalis* RESN

STATUS AND DISTRIBUTION

This species ranges across southern Canada, and is represented by many subspecies. The red-sided garter snake occurs in southeastern BC (Behler and King 1979).

There is an unconfirmed record of a red-sided garter snake at Redstreak Campground on 5 June 1963 park wildlife cards.

There are several records of red-sided garter snakes in MRNP, and one from GNP (Van Tighem and Gyug 1984). It has not been seen in BNP and JNP (Holroyd and Van Tighem 1983) .

HABITAT

The park record was from open Douglas fir forest of the Montane Ecoregion.

RUBBER BOA ***Charina bottae*** **RUBO**

STATUS AND DISTRIBUTION

The rubber boa occurs in western Canada from southern B.C. to the southwest corner of Alberta (Behler and King 1979).

This species has been recorded in the vicinity of Radium Hot Springs since 1943 (Carl 1943). Rubber boas were reported along the nature trail above the hot pool in the spring of 1964, and in the pools during late summer of the same year (Seel 1965). None were recorded during the inventory.

HABITAT

The rubber boa has only been recorded in the vicinity of hot springs in the Montane Ecoregion.

4.3. BIRDS

The avifauna of KNP includes 191 species, nine of which are hypothetical. (Species names enclosed in brackets indicate hypothetical species for which no verified records yet exist)

The following species accounts are based on several sources of information. Cowan and Munro visited KNP in the summer of 1943. Munro and Cowan (1944) and K. Seel (1965) summarized all recorded observations of birds of KNP. K. Van Tighem summarized all historical data and reported on three years of detailed study between 1975 and 1977 (Van Tighem 1977). Recent data include records in Naturalist and Warden files, and observations made by the Canadian Wildlife Service wildlife inventory staff from 1981 to 1983.

Information from areas outside the park has been included where possible: Banff and Jasper National Parks (Holroyd and Van Tighem 1983) ; Yoho National Park (Wade 1977); Columbia valley (Johnstone 1949, Kaiser *et al.* 1977, Simpson and Kelsall 1978 and Caspell *et al.* 1979); and Lake Windermere District Christmas bird count data were also used for some species.

Density indices (DI) in the **Habitat** sections of some species accounts refer to estimated density of the species per hectare during the breeding season. These values are derived by the circular bird census plot method described in sections 2.1 and 3.1. Further information on estimated densities of several species is available in section 3.3. A checklist of the birds of KNP appears in Appendix I.

Nomenclature and species order follows the American Ornithologist's Union (A.O.U.) 1982 checklist. However, the four letter species code appearing at the right margin opposite each species name follows the Mountain Parks Wildlife Data Card species codes currently in the CANSIS computer system.

COMMON LOON ***Gavia immer*** **COLO**

STATUS AND DISTRIBUTION

The Common Loon breeds throughout most of Canada except for areas in the south-central prairies, and some arctic regions. In B.C. it breeds wherever there is suitable habitat (Godfrey 1966).

The Common Loon is an uncommon migrant and summer visitor in KNP. The earliest records are from Daer Pond and Dog Lake on 12 May, both in 1981 and 1982. Most records are from Dog Lake, from June to July. There is only one autumn record: two were seen on Floe Lake on 18 August 1976 (Van Tighem 1977). This, and a record from Kaufmann Lake in July 1975 (Van Tighem 1977), are the only records not from the Kootenay valley.

There is no evidence that this species breeds in KNP. The summer records are probably of non-breeders, although Common Loons breed commonly in the Columbia valley. There are several breeding records from BNP and JNP (Holroyd and Van Tighem 1983) .

HABITAT

In KNP, the Common Loon may be found on lakes in the Montane and Subalpine Ecoregions.

PIED-BILLED GREBE *Podilymbus podiceps* PBGR

STATUS AND DISTRIBUTION

The Pied-billed Grebe occurs across southern Canada from coast to coast (Godfrey 1966). This species breeds in central and southern B.C. and winters on the southwestern coast.

The Pied-billed Grebe is a rare summer resident of KNP. It has only been observed at two locations for a total of five records. The first park record is one from Sora Pond on 20 May 1982 (MMP). Individuals have been observed twice more in this location: on 19 August 1982 (MMP) and on 19 July 1983 (RMW). The other records are from Sundew Pond: a pair on 9 June 1982 (MMP) and one on 19 May 1983 (RMW).

There is no direct nesting evidence, although the presence of a pair in ideal habitat during the breeding season indicates that they likely bred.

HABITAT

In KNP, the Pied-billed Grebe has occurred in shallow heavily vegetated ponds in the Montane Ecoregion. This habitat is limited to a few locations in the Kootenay valley.

HORNED GREBE *Podiceps auritus* HOGR

STATUS AND DISTRIBUTION

In Canada, Horned Grebes breed from the Yukon and NWT to southern Ontario and a few areas along the Atlantic Coast (Godfrey 1966).

The first record is of one at Dog Lake on 24 August 1973 (naturalist files).

The Horned Grebe is a rare migrant and rare summer resident of KNP. Spring migration is in April and May with all observations coming from the Kootenay valley. The earliest spring record is one from Sundew Pond on 26 April 1978 (LRH). The only autumn record is the above observation from Dog Lake.

On 13 May 1981, a pair of Horned Grebes was observed at Sora Pond (LRH). A mating display was observed on 21 May (RMW) and the pair remained throughout the summer.

The Horned Grebe is a common breeder in the Columbia valley adjacent to the park. They do not breed in BNP and JNP (Holroyd and Van Tighem 1983) .

HABITAT

The Horned Grebe is found in shallow lakes and ponds in the Montane Ecoregion of KNP. A pair was frequently observed, and probably bred in the heavy cattail vegetation of Sora Pond. Horned Grebes prefer water bodies with emergent vegetation (Godfrey 1966).

RED-NECKED GREBE *Podiceps grisegena* REGR

STATUS AND DISTRIBUTION

The Red-necked Grebe has a breeding range in Canada from the Yukon south through B.C. and east to Ontario. The Pacific and Atlantic coasts are wintering areas for this species (Godfrey 1966).

The first park record is of a road killed individual at Kootenay Crossing on 25 April 1979(park wildlife cards).

The Red-necked Grebe is a rare migrant in KNP. There are only seven records, all in the Kootenay valley from late April to mid-June. The earliest spring record is 25 April (see above) and the latest is one from Kootenay Pond on 10 June 1981 (RMW). The species has only been recorded at Daer Pond, Dog Lake, and Kootenay Pond.

The Red-necked Grebe is a rare breeder in BNP and JNP (Holroyd and Van Tighem 1983) and a common breeder in the Columbia valley.

HABITAT

Red-necked Grebes occur in ponds of the Montane Ecoregion in KNP. In breeding season they frequent lakes and sluggish rivers, especially those with emergent vegetation (Godfrey 1966).

MANAGEMENT CONSIDERATIONS

The Red-necked Grebe is suffering a population decline in North America, and has been placed on the Blue List published by **American Birds** (Tate 1982).

EARED GREBE *Podiceps nigricollis* EAGR

STATUS AND DISTRIBUTION

The Eared Grebe breeds from the central and southern interior of B.C. to southern Manitoba. It winters off the southern coast of B.C. (Godfrey 1966).

The Eared Grebe is a rare migrant in KNP. There are two spring records from Dog Lake, one on 16 May 1977 (KVT) and one on 16 May 1981 (PDE). There is an autumn record of three from Dog Lake on 13 August 1975 and another of one at Floe Lake on 28 August 1976 (KVT).

The Eared Grebe breeds in the Columbia valley NEAT Canal Flats and in the upland ponds behind Steamboat Mtn (Kaiser *et al.* 1977). It is considered an uncommon or rare migrant in the other mountain national parks (Wade 1977, Holroyd and Van Tighem 1983).

HABITAT

In KNP, the Eared Grebe has been observed on lakes in the Montane and Subalpine Ecoregions. Eared Grebes nest in marshy areas of freshwater ponds or lakes (Godfrey 1966).

WESTERN GREBE *Aechmophorus occidentalis* WEGR

STATUS AND DISTRIBUTION

The Western Grebe breeds primarily in Western Canada from northern Alberta to southern Manitoba. In B.C., nesting colonies are restricted to a few areas in the interior: Shuswap Lake near Salmon Arm, near the north end of Okanagan Lake, and at Creston marsh (Weber 1980).

The Western Grebe is a rare migrant in KNP. The first park record is of one seen at Floe Lake on 24 September 1966 (IDJ). There are two spring records: one seen along the Vermilion River near Mt. Wardle on 11 May 1978 and one near the Numa picnic area on 25 May 1974 (naturalist files). There are four autumn records of single individuals, the latest being at Kootenay Crossing on 31 October 1978 (LRH). Most park records are probably of individuals forced down by inclement weather.

The Western Grebe is a rare migrant in BNP and JNP (Holroyd and Van Tighem 1983) . It occurs in large migrant flocks in the Columbia valley but does not breed (Kaiser *et al.* 1977).

HABITAT

In KNP, the Western Grebe occasionally has been observed in wetlands of the Montane and Subalpine Ecoregions.

MANAGEMENT CONSIDERATIONS

The Western Grebe is on the Blue List published by **American Birds** (Tate 1982). It is regarded as a threatened species in B.C., since the population continues to decline towards an endangered status (Weber 1980).

GREAT BLUE HERON *Ardea herodias* GRHE

STATUS AND DISTRIBUTION

The breeding range of the Great Blue Heron extends across south-central Canada. In B.C., heronries occur from the north coast and Queen Charlotte Islands to coastal areas of Vancouver Island and the lower mainland. A few areas in the southern interior also support nesting colonies (Mark 1976).

The Great Blue Heron is an uncommon migrant and summer visitor to KNP. The first park record is of one along the Kootenay River near Crook's Meadow on 13 July 1972 (naturalist files). All records are from June and July, mostly from areas in the Kootenay valley. There are two sightings from the north end of the park: one at Kaufmann Lake on 7 August 1981 (D. Alger - CWS) and another along the creek below Helmet Falls on 21 August 1982 park wildlife cards.

Great Blue Herons are uncommon migrants in BNP and JNP (Holroyd and Van Tighem 1983) . Several active colonies currently exist along the Columbia River near the park: at the north end of Columbia Lake, north of Brisco, and south of Parsons (Forbes 1973). They are regularly seen in the Columbia valley during Christmas bird counts.

HABITAT

The Great Blue Heron is found primarily in the Montane Ecoregion near lakes, streams and along the Kootenay River floodplain. During migration, herons may be found near lakes and streams in the Subalpine Ecoregion. Normally, this species feeds at river edges, marshy areas of lakes and ponds, wetlands, and alluvial meadows.

MANAGEMENT CONSIDERATIONS

The Great Blue Heron is on the Blue List published by **American Birds** (Tate 1982). It has been listed as a species of "Special Concern" in B.C. due to a population decline resulting from destruction of nesting habitat due to land development practices within the province (Weber 1980).

WHSN

TUNDRA SWAN *Cygnus columbianus*

STATUS AND DISTRIBUTION

The Tundra Swan breeds across Alaska and arctic Canada to Baffin Island (Farrand 1983).

The Tundra Swan is a rare migrant in KNP. There are two observations, both from the spring. The first record is of a flock of 65 flying above Highway 93 near the north park boundary on 13 April 1979 (LRH). Two landed on the Kootenay River near "Kootenay Flats" on 3 May 1980 (JST).

Tundra Swans are rare migrants in BNP and JNP (Holroyd and Van Tighem 1983) . They are regular migrants through the Columbia valley (Kaiser *et al.* 1977). One very late migrant was observed on the 1980 Lake Windermere Christmas District bird count.

HABITAT

The Tundra Swan has only stopped briefly on the floodplain of the Kootenay River in the Montane Ecoregion of KNP.

TRSN

TRUMPETER SWAN *Cygnus buccinator*

STATUS AND DISTRIBUTION

The Trumpeter Swan breeds locally in northwestern regions of North America. A few areas in northern B.C. support nesting sites, and it has been re-introduced near Vernon (Godfrey 1966). B.C. contains important wintering areas for this species along the coast and at some interior lakes (Bellrose 1942).

One unverified record exists for the Trumpeter Swan in KNP. A flock of nine was reported from Daer Pond in October 1960 (park wildlife cards). They are very rare migrants in BNP and JNP (Holroyd & Van Tighem 1983). Large movements of swans, including Trumpeter Swans, occur during spring and autumn migration through the Columbia River valley (Kaiser *et al.* 1977).

HABITAT

Trumpeter Swans breed in lakes, ponds and sloughs which have extensive areas of marsh vegetation (Bellrose 1942). In KNP, required habitat is limited to very small areas of the Montane Ecoregion of the Kootenay River valley.

SNGO

SNOW GOOSE *Chen caerulescens*

STATUS AND DISTRIBUTION

The Snow Goose breeds across the high arctic regions of Canada to Greenland, and range south along the west and southwest coast of Hudson's Bay (Farrand 1983). Some Snow Geese winter in southwestern B.C.

Munro and Cowan (1944) reported a large flock flying above Dolly Varden Cr. during the autumn of 1941.

The Snow Goose is a rare migrant in KNP. The Rocky Mountains are not part of their normal migration corridor but they have been observed eight times since 1965. Most records (six) are from the spring. The earliest are one near Kootenay Crossing on 30 April 1971 (warden files) and two flocks totalling 32 flying over the Kootenay valley on 30 April 1982 (MMP). The only recent autumn record is of four adults and three immatures that stopped in the Kootenay Crossing pasture on 29 September 1981 (PDE).

Small numbers of Snow Geese migrate through the Columbia valley. They are rare migrants in BNP and JNP (Holroyd and Van Tighem 1983) .

HABITAT

In KNP, records of this species are primarily from the Montane Ecoregion near the Kootenay and Vermilion rivers. During migration, Snow Geese typically stop to feed at fresh and saltwater marshes, lakes, sandbars, and wet fields (Godfrey 1966). The pasturelands near Kootenay Crossing occasionally attract geese.

CANADA GOOSE *Branta canadensis* CAGO

STATUS AND DISTRIBUTION

The Canada Goose breeds throughout Canada (Godfrey 1966).

In autumn 1943, Canada Geese were "seen commonly on migration" (Munro and Cowan 1944).

The Canada Goose is a common migrant and a rare summer resident in KNP. Spring migration is mainly during May, but one was seen on the Kootenay River on 13 March 1970 (warden files). The maximum count is 31 from Dog Lake on 15 May 1973 (park wildlife cards). There are three late records for June. Autumn migration occurs from late August to late September. The latest record is of a flock of ten flying above a ridge crest near Talc Lake on 27 September 1981 (DMP).

There is one breeding record for KNP; a female on a nest was discovered in the marsh at the south end of Dog Lake on 26 May 1981 (RMW).

The Canada Goose has been described as "one of the most characteristic species" of the Columbia valley, occurring in large numbers during the breeding season and throughout migration (Kaiser *et al.* 1977). Some geese overwinter in the Columbia valley and are regularly seen on the Lake Windermere District Christmas bird counts.

HABITAT

Canada Geese mainly occur in large ponds and lakes of the Montane and Subalpine Ecoregions during migration. Montane shrubby wetlands, rivers and meadows may also be used. In KNP, they nested in the VL2 adjacent to Dog Lake where there is abundant marshy vegetation.

GREEN-WINGED TEAL *Anas crecca* GRTE

STATUS AND DISTRIBUTION

The Green-winged Teal breeds throughout B.C. and the Yukon across Canada to the Atlantic Coast. They occur in their greatest numbers in the wetlands of the northern boreal forest (Bellrose 1942). A small population winters along the southern coast of B.C. and in the Okanagan valley (Godfrey 1966).

The first KNP record is of a female seen in a "puddle" beside Highway 93 on 1 September 1965 (Seel 1965).

The Green-winged Teal is an uncommon migrant and rare summer resident in KNP. Spring migration is during May. The earliest record is of a male and two females at Sora Pond on 4 May 1981 (RMW). Autumn migration is from late August to October. The latest record is of two at Sora Pond on 11 October 1980 (LRH). During migration, there have been regular sightings of one to three ducks on the ponds of the Kootenay valley since 1965.

The first breeding evidence for the park was a female with five half-grown young on Daer Pond on 19 June 1976 (Van Tighem 1977). Pairs or individuals have been recorded irregularly during the summer on Sora Pond since 1976 and a family group, including four juveniles, was seen on 19 August 1982 (MMP).

Green-winged Teal breed in BNP and JNP (Holroyd and Van Tighem 1983) . Upland ponds of the Columbia valley are also used for nesting (Kaiser *et al.* 1977).

HABITAT

In KNP, the Green-winged Teal inhabits shallow lakes and ponds of the Montane Ecoregion of the Kootenay valley. Extensive cover in the form of sedge marsh or flooded willow stands are required for nesting. This species is most visible during migration, when it is found on open water of lakes and ponds.

MALLARD *Anas platyrhynchos* MALL

STATUS AND DISTRIBUTION

The Mallard ranges throughout the Northern Hemisphere. It breeds from the Pacific Coast of Canada east to southern Quebec and the Gulf of St. Lawrence (Godfrey 1966). Large numbers of Mallards winter along the B.C. coast (Bellrose 1942).

Munro and Cowan (1944) observed broods of young along Dolly Varden Cr. during the summer of 1943.

The Mallard is a common summer resident of KNP and the most common duck in KNP. The earliest record is of three pairs along the Kootenay River on 3 April 1981 (MMP, LRH). Autumn migration occurs from August until late October:one was seen along the Vermilion River on 27 October 1981 (MMP, LRH); an unusual sighting of a pair beside Highway 93 near the Paint Pots on 4 December 1980 (JST) constitutes the latest record. A maximum count of 12 was obtained on Daer Pond on 26 October 1979 (LRH).

There are several breeding records for KNP. The earliest is of a female with ten ducklings at the Redstreak sewage lagoon on 4 June 1970 (naturalist files). Broods have been commonly observed on water bodies of the Kootenay valley. There is one record from the Vermilion Crossing pond in July 1976 (KVT).

Small populations of Mallards remain in the Columbia valley throughout the winter in areas with open water. A total of 182 was seen on the 1982 Lake Windermere District Christmas Bird Count.

HABITAT

Mallards nest in the Montane Ecoregion of KNP near ponds, lakes, and in marshes. Lakes, ponds, wetlands, marshes, temporary ponds and rivers of the Montane and Subalpine Ecoregions are utilized during migration.

Mallards nest in upland areas, usually within 100 metres of open water, or in marshes. Dense vegetation is required for cover (Bellrose 1942).

NORTHERN PINTAIL *Anas acuta* PINT

STATUS AND DISTRIBUTION

The Northern Pintail has a circumpolar distribution, the greatest of any of the waterfowl. It breeds throughout the interior of Canada except the high arctic regions and many winter along the southern coast of B.C.(Godfrey 1966).

The Northern Pintail is a rare migrant and summer visitor in KNP. The first park record was at Dog Lake on 1 June 1976 naturalist files, and a road-killed female was collected near Vermilion Crossing in late August of the same year. The earliest spring record consists of a male at Kootenay River flats on 3 April 1981 (LRH). The latest autumn sighting is a female at Daer Pond on 5 October 1981 (LRH, MMP). During 1977, four Northern Pintails inhabited the Kootenay Ponds during the summer months (Van Tighem 1977).

The Northern Pintail is an uncommon migrant in Banff and Jasper National Parks (Holroyd and Van Tighem 1983). Northern Pintails move through the Columbia valley during migration, with peak numbers of up to 250 birds occurring in late October (Caspell *et al.* 1979).

HABITAT

In KNP, the Northern Pintail occurs on lakes, ponds, and rivers of the Montane Ecoregion.

BLUE-WINGED TEAL *Anas discors* BLTE

STATUS AND DISTRIBUTION

The Blue-winged Teal breeds throughout North America. In Canada, it occurs from the Yukon border throughout B.C. and across southern Canada (Godfrey 1966).

The first park record is of three males near Kootenay Crossing on 15 May 1965 (Seel 1965).

The Blue-winged Teal is an uncommon migrant and a rare summer resident in KNP. Almost all records are from spring migration (May and early June) in ponds and lakes throughout the Kootenay valley. The earliest record is of one male on Sora Pond on 4 May 1981 (LRH). The maximum count is 20 ar Daer Pond on 12 May 1981 (LRH). The Blue-winged Teal has been observed only rarely during the summer. There are a few autumn records with the latest, and maximum count consisting of a flock of 19 females and juveniles on Daer Pond on 13 September 1981 (MMP).

There is at least one breeding record. A female with five half-grown young was seen at Dog Lake on 31 August 1982 (MMP). A single female and immature were also seen at Dog Lake on 13 September 1981 and may have bred (MMP). Several nest records are known from Banff and Jasper National Parks (Holroyd and Van Tighem 1983).

Blue-winged Teal breed in the lagoons and upland ponds of the Columbia valley (Kaiser *et al.* 1977). In 1982, four Blue-winged Teal were seen on the Columbia River during the Lake Windermere District Christmas bird count.

HABITAT

In KNP, Blue-winged Teal inhabit lakes, ponds, rivers, and temporary ponds the Montane Ecoregion. They prefer to nest in grassy vegetation near water such as ponds, sloughs, lakes, marshes, and along the shores of rivers and streams (Godfrey 1966).

CINNAMON TEAL *Anas cyanoptera* CITE

STATUS AND DISTRIBUTION

In Canada, the Cinnamon Teal breeds across southern regions of the western provinces to Saskatchewan. It ranges north to the Cariboo-Chilcotin parklands in B.C. (Godfrey 1966).

This rare migrant has only been observed once in the park. A pair were observed at Sora Pond on 31 May 1983 (MMP, RMW).

Cinnamon Teal occur throughout the Columbia valley during migration. They may remain during the summer months but their breeding status is unknown(Caspell *et al.* 1979).

This species is an uncommon spring migrant and summer visitor to BNP and JNP (Holroyd and Van Tighem 1983) .

HABITAT

In KNP, the Cinnamon Teal has only occurred in a pond with extensive marshy vegetation in the Montane Ecoregion.

NORTHERN SHOVELER *Anas clypeata* SHOV

STATUS AND DISTRIBUTION

In Canada, the Northern Shoveler is found primarily in the Yukon and western NWT across the western provinces. The Northern Shoveler breeds throughout the interior of B.C. (Godfrey 1966).

The Northern Shoveler is considered an uncommon migrant in BNP and JNP (Holroyd and Van Tighem 1983). Small numbers migrate through the Columbia valley with autumn populations peaking in late October on Columbia Lake (Caspell *et al.* 1979). They may be found to breed in this region as well (Kaiser *et al.* 1977).

The Northern Shoveler is a rare migrant and summer visitor in KNP. There are three spring records, the earliest being a male on Kootenay Pond on 28 April 1983 (MMP). The only summer record is of a male in a flooded gravel pit beside the Kootenay River on 21 June 1983 (MMP). Two fall records exist, the latest is of a female at Daer Pond on 16 September 1982 (LRH). The maximum count is seven at Dog Lake on 16 May 1977 (LRH). All observations have been from the Kootenay valley.

HABITAT

The Northern Shoveler may be found on lakes and ponds in the Montane Ecoregion.

AMERICAN WIGEON *Anas americana* AMWI

STATUS AND DISTRIBUTION

The American Wigeon ranges through northwestern North America from Alaska, east to the Great Lakes of Ontario, and south to California. American Wigeons breed in interior B.C. and winter along the coast (Godfrey 1966).

The American Wigeon is an uncommon migrant and rare summer resident in KNP. The earliest spring record is on 28 April 1983 when three females and four males were seen on Kootenay Pond (MMP). Most observations of the American Wigeon have been from autumn migration, which extends from August to late October. The latest record is of one female on 26 October 1981 and the maximum count 16 on 28 August 1980, both from Sora Pond (LRH). Almost all records have been from the Kootenay valley.

There are two summer records for KNP, one of which is the only breeding record. A pair with two young was seen on the Redstreak sewage lagoon at the southwest boundary of the park on 3 July 1980 (LRH).

The American Wigeon does not breed in Banff and Jasper National Parks (Holroyd and Van Tighem 1983). Small numbers nest in the Columbia valley, and up to 3000 use this area during migration (Caspell *et al.* 1979). A few individuals winter in the East Kootenays.

HABITAT

The American Wigeon occurs on lakes, ponds, marshes, and rivers in the Montane Ecoregion of KNP. They prefer to nest near water in marshlands.

REDHEAD *Aythya americana* REDH

STATUS AND DISTRIBUTION

The Redhead breeds primarily in the western provinces of Canada from the mountain basins of the B.C. interior to the boreal forest of northern Alberta, and prairie regions of Saskatchewan and Manitoba (Godfrey 1966).

The Redhead is a rare migrant in KNP. There is only one record: a male at Vermilion Crossing pond on 7 October 1981 (LRH).

The Redhead is an uncommon migrant in BNP and JNP (Holroyd and Van Tighem 1983). The Columbia valley is a migration corridor for this species. Spring migration occurs in April and May, and a peak of 1700 Redheads occurred in late October 1979 during fall migration (Caspell *et al.* 1979).

HABITAT

The only KNP record is from a pond within the Montane Ecoregion.

RING-NECKED DUCK *Aythya collaris* RIDU

STATUS AND DISTRIBUTION

In Canada, the Ring-necked Duck has a scattered distribution from central and southern B.C. across the northern prairies to the Atlantic provinces. Ring-necked Ducks winter off the extreme southern coast of B.C. (Godfrey 1966). The open prairie and arctic tundra are avoided, and this species reaches its highest breeding densities in the boreal forest of northern Alberta (Belrose 1942).

The Ring-necked Duck is an uncommon migrant and summer resident in KNP. It may be found in ponds throughout the Kootenay valley and Redstreak area in pairs or small mixed flocks.

During spring migration, Ring-necked Ducks arrive in early May and are regularly seen on the Kootenay Ponds, Dog Lake, Daer Pond, Sora Pond, and Sundew Pond (naturalist files, CWS). The earliest record is five at Sora Pond on 4 May 1981 (LRH). Most of the autumn migration records for KNP are during September, with one record in late October. Up to 12 have been seen at one time.

The first nest record for the park was at Nixon Lake on 20 June 1979 when a female was discovered on a nest with five eggs (LRH). In July 1981, a brood of eight young ducklings with a female was seen on Dog Lake (RMW).

This species breeds locally in BNP and JNP (Holroyd and Van Tighem 1983) , the Columbia valley (Caspell *et al.* 1979), and in YNP (Wade 1977).

HABITAT

The Ring-necked Duck breeds in ponds, lakes, and marshes in the Montane Ecoregion of the Kootenay valley. Nests are constructed on floating vegetation near shoreline, where they are concealed by the emergent vegetation.

LESSER SCAUP ***Aythya affinis*** **LESC**

STATUS AND DISTRIBUTION

The Lesser Scaup breeds in western Canada north through the Yukon and western NWT and from the B.C. interior through the prairie provinces. Wintering grounds are along the southern coast of B.C. (Godfrey 1966).

The Lesser Scaup is a rare migrant and summer visitor in KNP. Spring migration is in May and early June. The earliest record is of one male at Kootenay Pond on 13 May 1970 (naturalist files). There are two summer records, both from Sundew Pond. All autumn records are from October, the latest being five on Daer Pond on 26 October 1979 (LRH). The only record outside of the Kootenay valley is of a pair near Mount Wardle on 21 May 1980 (LRH). The maximum count is six on Sora Pond on 7 October 1981 (LRH).

There is no breeding evidence for KNP.

Lesser Scaup are uncommon breeders in BNP and JNP (Holroyd and Van Tighem 1983) . The species is a common migrant in the Columbia valley.

HABITAT

The Lesser Scaup is found in wetlands of the Montane Ecoregion of KNP.

HARLEQUIN DUCK ***Histrionicus histrionicus*** **HADU**

STATUS AND DISTRIBUTION

The Harlequin Duck is an inhabitant of the northern regions of North America. It breeds in Labrador and Baffin Island in eastern Canada, and in mountainous regions of western Canada. Harlequin Ducks winter off the Pacific and Atlantic coasts (Godfrey 1966).

Munro and Cowan (1944) reported Harlequin Ducks from Sinclair and Tokumm Creeks in June 1943.

The Harlequin Duck is an uncommon summer resident in KNP. Spring migration occurs in May. The earliest record is a pair near Iron Gates tunnel on 12 May 1982 (LRH). Most records are from areas within the Sinclair Canyon. An unusual summer record of a single male is from the Redstreak sewage lagoon on 4 July 1964 (naturalist files). The Harlequin Duck has also been observed twice along Tokumm Creek (MMP, Munro and Cowan 1944). There are no autumn sightings.

There are several nesting records for KNP. Broods of three to five young were raised from 1959 to 1962 in Sinclair Creek near the hot pool (naturalist files). A female nested by the McKay Creek reservoir during the summer of 1963, and raised five young (Seel 1965).

The Harlequin Duck is an uncommon breeder in BNP and JNP (Holroyd and Van Tighem 1983) . A brood was discovered on a glacial subalpine lake in the Purcell Mountains near Radium (MMP).

HABITAT

In KNP, the Harlequin Duck occurs in ponds and fast flowing streams of the Montane and Lower Subalpine Ecoregions. It has been observed on lakes and streams of the Upper Subalpine Ecoregion in areas adjacent to the park.

Nests are typically located along the shores of mountain streams. Harlequin Ducks may be seen along rivers during migration.

RED-BREASTED MERGANSER ***Mergus serrator*** **REME**

STATUS AND DISTRIBUTION

The Red-breasted Merganser ranges widely over the arctic and boreal regions of Canada from the Yukon to the Atlantic coast. It breeds in the northwestern corner of B.C. and utilizes coastal waters during the winter (Godfrey 1966).

The Red-breasted Merganser is a very rare migrant in KNP. There are two spring records. A male was seen on Olive Lake on 27 May 1976 (KVT) and two females were reported from the Redstreak sewage lagoon on 23 April 1980 (LRH).

The Red-breasted Merganser is a very rare migrant in BNP and JNP (Holroyd and Van Tighem 1983) and a migrant over much of B.C. It winters regularly off the B.C. coast and occasionally in the southern interior (Godfrey 1966).

HABITAT

The only park records are from a Lower Subalpine lake and a disturbed Montane wetland area.

RUDDY DUCK ***Oxyura jamaicensis*** **RUDU**

STATUS AND DISTRIBUTION

The Ruddy Duck breeds primarily in western Canada, from southcentral B.C. to Manitoba. The southern coast of B.C. contains wintering grounds for the Ruddy Duck (Godfrey 1966).

The Ruddy Duck is a rare migrant in KNP.

During mid-May of 1965, a pair of Ruddy Ducks was observed at the Kootenay Crossing Marsh. They appeared to be initiating a nest, but disappeared afterwards (Seel 1965). This species was not seen again until 1983 when a female was seen on Kootenay Pond on 4 June (RMW).

Although this species may nest in a few locations in the Rocky Mountain Trench, it is not known to breed in the mountains.

HABITAT

Ruddy Ducks have been reported on lakes and ponds of the Montane Ecoregion of KNP.

COMMON MERGANSER ***Mergus merganser*** **COME**

STATUS AND DISTRIBUTION

The Common Merganser occurs over much of Canada except the southern prairies and high arctic regions. It breeds throughout most of B.C. (Godfrey 1966).

The Common Merganser is a rare summer resident of KNP. Spring migration occurs in May. The earliest record is of a pair on the Kootenay River near McLeod Meadows on 3 May 1980 (JST). Autumn migration extends from late August through October. The latest record is of four males and a female on the Kootenay River on October 28 1982 (MMP). There are summer records from several areas along the Kootenay and Vermilion rivers. There is an unusual record of a male flying over a mountain peak near Ottertail Pass at close to 2500 m. elevation on 28 June 1983 (RMW)

There are two breeding records. A family group was seen on the Kootenay River near Daer bridge on 3 August 1977 (LRH) and a female with seven immatures was observed on the Vermilion River on 17 July 1983 (JWV). Juveniles were seen on Dog Lake in late October 1981 (LRH) but were probably migrants.

HABITAT

The Common Merganser occurs on rivers and lakes of the Montane and Lower Subalpine Ecoregions of KNP. They require rivers and lakes in wooded regions for breeding (Godfrey 1966).

HOODED MERGANSER ***Lophodytes cucullatus*** **HOME**

STATUS AND DISTRIBUTION

The Hooded Merganser is distributed across most of southern Canada, except for the prairie regions. It breeds in most areas of central and southern B.C. and winters in some areas in the south of the province (Godfrey 1966).

The Hooded Merganser is a rare migrant in KNP with one spring record to date. A male was seen on Kootenay Pond on 28 April 1983 during CWS pond surveys (MMP).

The Hooded Merganser is an uncommon migrant and summer visitor in BNP and JNP (Holroyd and Van Tighem 1983).

HABITAT

Hooded Mergansers utilize ponds of the Montane Ecoregion of KNP during migration.

BUFFLEHEAD ***Bucephala albeola*** **BUFF**

STATUS AND DISTRIBUTION

The Bufflehead occurs across Canada from B.C. to Quebec and north to the southern Yukon and NWT. In B.C. they breed throughout the forested and mountainous regions of the interior. During the winter the Bufflehead may be found along the Pacific and Atlantic coasts (Godfrey 1966).

The Bufflehead is a common migrant and summer resident of KNP. They have been observed from April to November on virtually every available water body in the Kootenay valley. Spring migration occurs in late April and May. The earliest record is of a pair in the Kootenay River near Kootenay Crossing on 26 April 1980 (JST). Autumn migration begins in late August. The latest record is of two from the second Kootenay Pond on 2 November 1975 (park wildlife cards). Buffleheads have been seen in pairs or small flocks of up to seven.

Broods have been seen on Nixon Lake, Meadow Creek Pond, Sundew Pond, the second Kootenay Pond, and Sora Pond (naturalist files, CWS). The earliest is a brood of five on the second Kootenay Pond on 17 June 1976 (naturalist files). An unusually large brood of 12 was seen on Nixon Lake on 8 July 1981 (RMW).

HABITAT

In KNP, the Bufflehead occurs on water bodies of the Montane Ecoregion of the Kootenay valley. Nests are located in cavities of trees in woodlands near ponds and lakes.

BARROW'S GOLDENEYE *Bucephala islandica* BAGO

STATUS AND DISTRIBUTION

In Canada, Barrow's Goldeneye breeds in southern Yukon to B.C., and limited regions of Labrador and the Hudson's Bay (Godfrey 1966). The Cariboo-Chilcotin plateaus of B.C. contain the largest breeding densities of this species (Bellrose 1942). Most Barrow's Goldeneye winter along the Pacific coast.

Barrow's Goldeneye is an uncommon migrant and rare summer resident in KNP. Spring migration is in April and May. A very early male was observed on the Kootenay River on 31 March 1965 ((Seel 1965)). A number of non-breeding fema goldeneyes, probably of this species have been reported in the summer from various locations in the Kootenay River (naturalist files). There is also a record of a female Barrow's Goldeneye on a subalpine pond in Goodsir Pass on 27 July 1982 (DMP). Autumn migration occurs in September and October. The latest record is of four pairs seen on Kootenay Pond on 9 October 1965 ((Seel 1965)).

There are no breeding records for KNP although it is a fairly common breeder throughout BNP and JNP (Holroyd and Van Tighem 1983) and the Columbia valley.

HABITAT

In KNP, Barrow's Goldeneye occurs on lakes and ponds of the Montane and Subalpine Ecoregions, and rarely in marshes and rivers.

COMMON GOLDENEYE *Bucephala clangula* COGO

STATUS AND DISTRIBUTION

The Common Goldeneye is an inhabitant of lakes of the boreal forest in North America. It ranges through B.C.'s interior and the Yukon across northern Canada to the Atlantic. Wintering grounds are off the Pacific and Atlantic coasts (Godfrey 1966).

A rare migrant in KNP, the Common Goldeneye has been seen as early as 4 April on the Kootenay River, and as late as 16 September on Daer Pond (LRH). They have been observed on the Redstreak sewage lagoon, the Kootenay Ponds, and Daer Pond (naturalist files). A pair was seen on the Kootenay River near the "Picnic Site" for several weeks in April 1982 during CWS migration surveys. A maximum of four have been counted at one time in the park.

The Common Goldeneye is a common migrant in BNP and JNP (Holroyd and Van Tighem 1983). They breed in the Columbia Valley, and leave this area early during autumn migration, peaking in numbers during late September (Kaiser *et al.* 1977). Some individuals overwinter in this area, and up to 94 have been sighted during the Lake Windermere District Christmas bird counts.

HABITAT

The Common Goldeneye inhabits lakes, ponds and rivers in the Montane Ecoregion of KNP.

WHITE-WINGED SCOTER *Melanitta fusca* WHSC

STATUS AND DISTRIBUTION

The White-winged Scoter breeds throughout western Canada except for some mountain regions. In B.C., they occur in the north and central regions of the province and winter along the Pacific coast (Godfrey 1966).

The White-winged Scoter is a rare migrant and summer visitor in KNP. All records but one are from ponds and lakes in the Kootenay valley. The only other observation, and maximum count, is 25 seen on Floe Lake on 13 August 1980 (naturalist files). Spring migration occurs from mid-May to early June. The earliest record is a male at Kootenay Pond on 15 May 1981 (RMW). There are a few summer records of non- or post-breeding individuals. Autumn migration is in August and September. The latest record is of a male on Dog Lake on 6 September 1974 (naturalist files).

HABITAT

White-winged Scoters have been found on deeper waters of lakes and ponds of the Montane and Subalpine Ecoregions.

SURF SCOTER *Melanitta perspicillata* SUSC

STATUS AND DISTRIBUTION

The Surf Scoter breeds within the northern boreal forest of Canada. It nests in northern and central B.C. and winters off the Pacific coast (Godfrey 1966).

The Surf Scoter is a rare migrant in KNP. There are only two observations, both from the spring of 1981. A flock of two males and a female was observed on Dog Lake on 16 May (PDE) and a male was seen on Kootenay Pond on 30 May (RMW, KVT).

The Surf Scoter is a fairly common migrant during the spring and an uncommon autumn migrant in BNP and JNP (Holroyd and Van Tighem 1983) .

HABITAT

In KNP, Surf Scoters have been found on the deeper waters of lakes and ponds in the Montane Ecoregion.

OSPREY *Pandion haliaetus* **OSPR**

STATUS AND DISTRIBUTION

The Osprey inhabits tropical and temperate regions of all of the continents (Godfrey 1966). It occurs throughout most of B.C. during the breeding season. and is most common along Columbia Lake and in the Creston valley (Beebe 1974).

The Osprey is a rare migrant and summer visitor to KNP. Most records are of wandering individuals from the Columbia valley. The earliest is of one at Daer Pond on 14 May 1982 (DMP) and the latest is one at Kootenay Pond on 16 September 1982 (LRH). All records are from the Kootenay valley except one in Sinclair Canyon on 25 May 1979 (LRH).

There are no breeding records due to the scarceness of suitable habitat in KNP.

Ospreys are common breeders in the Columbia valley and are known to breed in YNP (Wade 1977) and BNP and JNP (Holroyd and Van Tighem 1983) .

HABITAT

The Osprey makes infrequent trips into the Montane Ecoregion of KNP, where it visits the larger lakes and ponds of the Kootenay valley. This species lives almost exclusively on fish and is limited to breeding near bodies of water with large enough populations of fish to support them.

MANAGEMENT CONSIDERATIONS

The Osprey is on the **American Birds** Blue List due to the detrimental effects of pesticides on its breeding success (Tate 1982). Three Osprey were destroyed in KNP during a predator control program in June 1934 (warden records).

BALD EAGLE *Haliaeetus leucocephalus* **BAEA**

STATUS AND DISTRIBUTION

The Bald Eagle breeds throughout forested regions of Canada but is most common in coastal areas. Southern B.C. contains populations of wintering Bald Eagles (Godfrey 1966).

The first park records are from the summer of 1956 (warden files). Since then, there have been several reports of the species from KNP.

The Bald Eagle is an uncommon migrant and rare summer visitor to KNP. It has been observed throughout the year, except for the deep winter months of December and January. Most records are from the Kootenay valley during migration. Spring migration is from March until May. A very early record is of an adult seen near Mount Harkin on 3 February 1983 (DMP). A second early record is of one near Dolly Varden Creek on 6 March 1981 (BRS). There are a few summer records, mostly from the extreme southern portions of the park. Autumn migration occurs from late August until late November. The latest record is of one that remained near Mount Harkin until 25 November 1982 feeding on a roadkilled elk (MMP). A maximum of three have been observed at one time.

There are no breeding records although the species nests commonly along the Columbia valley just outside the park. Bald Eagles have recently nested at the Vermilion Lakes in BNP and have historically nested in JNP (Holroyd and Van Tighem 1983) . Up to seven Bald Eagles have been observed on Lake Windermere District Christmas bird counts.

HABITAT

Bald Eagles are found in the Montane and Lower Subalpine Ecoregions of KNP. Lakes, river floodplains, and forest openings such as meadows or shrubby wetlands are used by this species. The open Douglas fir forests of the Columbia benchlands are adjacent to their breeding habitat and Bald Eagles may be seen hunting in these areas. Roadkilled ungulates may attract eagles to Highway 93 during migration.

NORTHERN HARRIER *Circus cyaneus* MAHA

STATUS AND DISTRIBUTION

The Northern Harrier is found in the interior of B.C. during the summer and uncommonly winters in some southern regions of the province (Godfrey 1966).

The Northern Harrier is a rare migrant in KNP. The earliest record is of one seen near Redstreak on 4 May 1970. Autumn migration extends from mid-August until early October. There are five autumn records, the latest being an individual seen south of Airport Meadows on 6 October 1981 (DMP). All sightings have been of single birds or pairs.

The Northern Harrier is a summer resident of the Wilmer Wildlife Area of the adjacent Columbia valley. They occasionally winter in the Columbia valley with a maximum of four having been recorded on Christmas bird counts.

HABITAT

The Northern Harrier has been found from the Montane to Alpine Ecoregion of KNP during migration. They are found in open meadows, along ridge crests, and near marshes and lakes. They occur in similar habitats in BNP and JNP (Holroyd and Van Tighem 1983) .

SHARP-SHINNED HAWK *Accipter striatus* SHHA

STATUS AND DISTRIBUTION

In North America, the Sharp-shinned Hawk breeds from treeline in Canada south to the southern U.S.A. It winters from southern B.C. to Central America (Farrand 1983).

The Sharp-shinned Hawk was first recorded for KNP during June 1943, when an individual was seen in Sinclair Canyon (Munro and Cowan 1944). Since that time it has remained an uncommon summer resident in KNP.

Spring migration is during April and May. Sharp-shinned Hawks have been seen as early as 5 April by the Hot Springs pool (Seel 1965). During the summer, Sharp-shinned Hawks may be seen throughout the park from the Redstreak area to the Vermilion Pass burn. No more than two have been seen at a time. Autumn migration extends into October, with a late record on 22 October 1980 when an adult was sighted four miles north of Kootenay Crossing (park wildlife cards).

There are no nesting records to date but the Sharp-shinned Hawk probably breeds rarely in the park.

HABITAT

In KNP, the Sharp-shinned Hawk may be found in the Montane and Lower Subalpine Ecoregions. They inhabit river floodplains and lakeshores, mixed or coniferous forest, especially open Douglas fir, and burns.

SPECIES ATTRIBUTES

Sharp-shinned Hawks have been observed hunting small birds, and being pursued by Barn and Cliff Swallows (park wildlife cards). Two accipiters, probably of this species, were seen chasing an immature Bald Eagle in Kindersley Pass on 29 August (KVT). The Sharp-shinned Hawk is considered a "Blue List" species (Tate 1982).

COOPER'S HAWK *Accipiter cooperii* COHA

STATUS AND DISTRIBUTION

Cooper's Hawk breeds across the forested regions of southern Canada. In B.C., the southern regions serve as wintering areas for this species (Godfrey 1966).

Cooper's Hawk is an uncommon summer resident in KNP. Spring migration is during May. The earliest record is of one at the base of Mount Wardle on 21 May 1981 (RMW). During the summer, there have been infrequent observations of Cooper's Hawks from localities throughout the park. Cooper's Hawks have not been observed in KNP after late August. The latest is one seen on a slidepath near the Paint Pots on 24 August 1983 (RMW, DMP).

There is only one breeding record. A female on a nest was found by CWS staff at Stoddart Creek on 26 May 1983. There is no information on whether the young were successfully raised but none were observed in the area later in the year.

HABITAT

Cooper's Hawk inhabits the Montane and Lower Subalpine Ecoregions of KNP. They occur in open Douglas fir forest, mixed deciduous-coniferous forest, burned forest, avalanche slopes, and forest edges.

SPECIES ATTRIBUTES

The nest in KNP was located 15 m. up a mature Douglas fir. It was composed of sticks and contained four eggs. Cooper's Hawk is a "Blue List" species (Tate 1982) and care should be taken not to disturb nesting birds.

An adult Cooper's Hawk captured a Yellow-rumped Warbler near Sora Pond on 1 June 1976 (KVT).

NORTHERN GOSHAWK *Accipter gentilis* GOSH

STATUS AND DISTRIBUTION

The Northern Goshawk is found across Canada north to treeline. It often winters on its breeding range, although infrequent southern irruptions are known to occur (Farrand 1983).

The first park record was during the winter of 1942. In June 1943 a male was seen near Marble Canyon (Munro and Cowan 1944). The species was not recorded again until August 1965, when an immature was seen at the hot pool, and at Hector's Gorge (Seel 1965). During the 1930's, an unspecified number of "Blue Hawks" were documented as being destroyed in the park, which may have referred to the Northern Goshawk (warden files).

The Northern Goshawk is an uncommon permanent resident in KNP. There are infrequent observations from all seasons, in many areas of the park. A roadkilled adult was collected in the Redstreak area in the spring of 1975 (naturalist files).

No nests have been found, although a pair was observed exhibiting mating behaviour on Vermilion Peak on 4 June 1983 (RMW). The Northern Goshawk is a rare breeding resident of BNP and JNP (Holroyd and Van Tighem 1983) .

HABITAT

Northern Goshawks are found throughout the Montane and Subalpine Ecoregions of KNP. On circular bird census plots, individuals were recorded on WH6 and WH8 in open and closed subalpine coniferous forest (C21,O13). They usually inhabit mixed forest with adjacent meadows or clearings, and deep coniferous forest (Godfrey 1966).

SPECIES ATTRIBUTES

Northern Goshawks have been observed killing Ruffed Grouse, and pursuing Belted Kingfishers, Killdeer and Red-tailed Hawks (naturalist files). A Northern Goshawk was being pursued by a small flock of Rosy Finchs along a ridgecrest at Goodsir Pass during the summer of 1983 (MMP).

SWAINSON'S HAWK *Buteo swainsoni* SWHA

STATUS AND DISTRIBUTION

Swainson's Hawk is a local breeder in western Canada, primarily in the southern prairie regions. It also occurs from the southern Yukon through interior regions of B.C. such as the Okanagan valley (Godfrey 1966).

Swainson's Hawk is a rare migrant in KNP. A dark-phase individual was reported along the Kootenay River near Dolly Varden during autumn migration (Seel 1965). On 15 April 1982 an adult was observed at McLeod Meadows during spring migration (DMP).

There are only seven records of this species in BNP and JNP (Holroyd and Van Tighem 1983). It is listed as a summer resident of the Wilmer Wildlife Area (Simpson and Kelsall 1978). An adult was perched in deciduous trees bordering the Columbia River near Radium in May 1982 (MMP, LRH).

HABITAT

Swainson's Hawk has been reported from the grassy roadside of Highway 93 and the Kootenay River floodplain in the Montane Ecoregion of KNP. This species normally inhabits plains, prairie and desert (Farrand 1983).

RED-TAILED HAWK *Buteo jamaicensis* REHA

STATUS AND DISTRIBUTION

The Red-tailed Hawk breeds north to treeline in Canada, and south to Central America (Godfrey 1966). The Red-tailed Hawk is a common summer resident of KNP. It is most often observed in the summer throughout the Kootenay valley. Spring migration is from late March to May, peaking in April. The earliest record is of one soaring near the Park administration building on 26 March 1973 (park wildlife cards). Autumn migration is from August to October. The latest migrant was sighted in the Redstreak area on 16 October 1982 (MMP).

The first Red-tailed Hawk nest for KNP was discovered at Crook's Meadow in 1943, although the site was not active (Munro and Cowan 1944). However, a pair nested in this vicinity again in 1965 producing two young (Seel 1965). Adults with fledged young were seen at McLeod Meadows during the summer of 1981, and immature Red-tailed Hawks have been seen near Kootenay Crossing and Radium Lodge. In spring 1982, a pair of adults occupied a territory near the Conservation Corps Camp road.

HABITAT

The Red-tailed Hawk breeds from the Montane to the Upper Subalpine Ecoregion of KNP. Most records are from the Montane Ecoregion of the Kootenay valley, where it occurs near meadows, lakes, and river floodplains and in open Douglas fir forest of the Columbia valley benchlands (park wildlife cards). In the Lower Subalpine Ecoregion of the Vermilion valley, Red-tailed Hawks occur near wetlands and along the floodplain of the Vermilion River. They are also recorded on avalanche paths in the Upper Subalpine Ecoregion of the Vermilion valley. On circular bird census plots, Red-tailed Hawks were found in closed mixed forests of DG6, and DR8, and in open subalpine coniferous forest of WH7.

ROUGH-LEGGED HAWK *Buteo lagopus* ROHA

STATUS AND DISTRIBUTION

The Rough-legged Hawk breeds throughout the subarctic and low Arctic regions (Godfrey 1966). It winters from southern Canada through most areas of the U.S.A. (Farrand 1983).

The Rough-legged Hawk is a rare migrant in KNP. It was initially recorded in KNP during spring migration on 2 June 1966, when an adult was observed several miles south of Vermilion Crossing (IDJ). All sightings thereafter have been during autumn migration, which extends from late August to early November. Individuals were sighted at Kootenay River Flats in September, McLeod Meadows in August, and south of Dolly Varden Cr. in October, with a late record near Settler's Road on 5 November 1979 (naturalist files). More recently, during the wildlife inventory, fall sightings occurred during September and October throughout the Kootenay valley at Mt. Harkin, Kootenay Crossing, Crook's Meadow, and near the Kootenay Viewpoint.

HABITAT

The Rough-legged Hawk occurs in the Montane Ecoregion of KNP. It frequents the grassy roadside allowance of Highway 93, and open areas such as meadows, river floodplains, and wetlands.

GOLDEN EAGLE *Aquila chrysaetos* GOEA

STATUS AND DISTRIBUTION

The Golden Eagle is a holarctic species found in North America, Eurasia, and North Africa (Godfrey 1966). It has disappeared over much of its range in North America, and is most common in mountainous regions of the west (Farrand 1983).

The Golden Eagle is primarily an uncommon summer resident of KNP, but may be seen during all months of the year. Initially recorded in 1943, a group of five was seen on an elk carcass at Kootenay Crossing (Munro and Cowan 1944). This record also represents the highest single count in KNP.

Golden Eagles begin to arrive in KNP in March, but most of the spring sightings occur in April and May.

To date, direct evidence of breeding has not been found for this species in KNP. Historical records mention a nest site near Mt. Wardle, but it has since been abandoned. An empty nest of a cliff ledge was discovered in the McKay Cr. drainage in 1981 (KVT). Active nests are reported in BNP and JNP (Holroyd and Van Tighem 1983).

Autumn migration lasts from September into November, with peak numbers occurring in November. Winter records include an adult near Dolly Varden in December 1967, one in Sinclair Canyon during January 1980 and one near the Conservation Corps Camp in December 1981 (park wildlife cards).

HABITAT

Golden Eagles inhabit the Lower Subalpine and Upper Subalpine Ecoregions of KNP. They occur in the Montane Ecoregion during migration and winter. On circular bird census plots Golden Eagles were recorded on SB3 and WH1, and v.t. C14, O13, and L5. During summer, Golden Eagles are seen along the high ridge crests of the McKay Cr. Kindersley Pass area, the Continental Divide, and Mt. Wardle.

AMERICAN KESTREL *Falco sparverius* KEST

STATUS AND DISTRIBUTION

The American Kestrel breeds from near treeline in Canada south to Mexico. It winters from southwestern B.C. as far south as Central America (Farrand 1983).

The American Kestrel is an uncommon summer resident of KNP. It is more common in the open forest and ranchlands of the Columbia valley (MMP). Spring migration occurs in April and May. The earliest record is one from the Redstreak area on 19 April 1978 (LRH). A maximum of three American Kestrels were seen in early May 1982 during migration surveys. Autumn migration is from late August to October. The latest record is of one female near Kootenay Crossing on 15 October 1981 (MMP).

The first breeding record for KNP was in June 1943 when a pair nested adjacent to Settler's Road (Munro and Cowan 1944). Since that time, most of the breeding records for KNP are from the vicinity of the Vermilion Pass Burn. In July 1970 a female nested in a burned tree, and a family group including three fledglings were seen near the Fireweed Trail in August 1973 (naturalist files). During the same year a pair initiated a nest north of McLeod Meadows, but the young died when the tree was blown down during a storm (naturalist files).

HABITAT

In KNP, American Kestrels have been found in the Montane and Lower Subalpine Ecoregions. An inhabitant of open country, the American Kestrel frequents burns, lakes, ponds, river floodplains, meadows, and avalanche slopes in KNP. American Kestrels were recorded on circular bird census plots in AT4, (S1). The American Kestrel is also known from the high alpine meadows and ridges of the Upper Subalpine Ecoregion in BNP and JNP, and the Purcell Mountains (MMP),

MERLIN *Falco columbarius* MERL

STATUS AND DISTRIBUTION

The Merlin breeds throughout the forested regions of Canada. It commonly winters in the southern interior and coastal areas of B.C. (Godfrey 1966).

The Merlin is a rare migrant in KNP. There are only five records, three during spring and two in the autumn. The earliest record is one seen at the Paint Pots on 13 May 1975 (KVT). Other spring records include individuals at Kootenay Pond and Dolly Varden Creek (naturalist files). The two autumn records are of single birds; one near Crook's Meadow on 22 August 1979 (LRH) and another at Daer Pond on 16 September 1982 (DMP).

HABITAT

Merlins occur in the Montane and Lower Subalpine Ecoregions of KNP. They migrate through the Upper Subalpine Ecoregion of BNP and JNP (Holroyd and Van Tighem 1983).

PRAIRIE FALCON *Falco mexicanus* **PRFA**

STATUS AND DISTRIBUTION

The Prairie Falcon ranges across the dry interior of western Canada. In B.C., it is known to breed in limited areas of the Cariboo Parklands, and the Okanagan Valley (Godfrey 1966).

The presence of this species as hypothetical on the KNP checklist is based upon an unverified sighting over the pasture at Kootenay Crossing (LRH, pers. comm).

The Prairie Falcon is a rare migrant and summer visitor in BNP and JNP. They occur almost exclusively in the valleys of the Front Ranges of these parks (Holroyd and Van Tighem 1983) . It is listed as a migrant in the Wilmer Wildlife Area of the Columbia valley (Simpson and Kelsall 1978).

SPRUCE GROUSE *Dendragapus canadensis* **SPGR**

STATUS AND DISTRIBUTION

The Spruce Grouse occurs throughout the coniferous forests of northern and western Canada (Godfrey 1966).

The Spruce Grouse is a common permanent resident in KNP. Recorded since autumn 1921 in warden diaries, the Spruce Grouse has the most widespread distribution of any grouse in the park.

Broods of up to ten have been recorded near the Kindersley Pass trail and McKay Cr., by lakes in the Kootenay valley, and along the Ochre and Tokumm Cr. trails in the Vermilion valley.

HABITAT

This species occurs most commonly in low elevation coniferous forests, particularly on floodplains, alluvial fans and lower slopes.

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=.04), followed by the Lower Subalpine Ecoregion (DI=.02). Ecosites on which the highest densities of this species occur are: HD3 (.59), AT1 (.24), DR2 (.19), and BY1 (.12).

The most important vegetation types are: Douglas fir/hairy wild rye (C1) (.88), white spruce/buffaloberry/feathermoss (C37) (.39), Engelmann spruce-subalpine fir/green alder (C25) (.12), and Engelmann spruce-subalpine fir/false azalea (C14) (.05) closed forests.

During winter track count transects, Spruce Grouse were recorded on BY3 and BY7 in forests dominated by lodgepole pine and Engelmann spruce.

BLUE GROUSE *Dendragapus obscurus* **BLGR**

STATUS AND DISTRIBUTION

In Canada, the Blue Grouse occurs throughout B.C. and the Rocky Mountains of Alberta, north to the southern Yukon and southwest NWT (Farrand 1983).

The Blue Grouse is an uncommon permanent resident in KNP. The first reference to this species was a 1920 warden diary which reported the south fork of Sinclair Cr. as "being alive with Blue Grouse". Most sightings since then have been in the Sinclair Cr. drainage on the slopes of Mt. Berland, along Sinclair Cr. on the Kindersley Trail, and at the Redstreak Campground (naturalist records). Blue Grouse migrate in winter to higher altitudes within subalpine forest, and may be less conspicuous during this time.

Females with young have been seen from mid-June to August (park wildlife cards). One nest was discovered at the Redstreak Campground in early July 1965 (Seel 1965). Broods have been recorded from the Vermilion Pass Burn, McKay Cr. Compound, Redstreak Campground, and Stoddart Cr. (naturalist files). Males were seen displaying on the dry subalpine slopes along upper Whitetail Cr. below Mt. Verendrye in early August 1982 (MMP) and at Stoddart Cr. on 29 June 1981 (RMW). Two males were observed on the open south slopes of Mt. Wardle in June 1983 (MMP).

HABITAT

Blue Grouse are commonest in the Montane Ecoregion (DI=0.06) but occur as high as the Upper Subalpine. Blue Grouse occur in open Douglas fir forest, dry rocky outcrops of the Lower Subalpine Ecoregion and in coniferous forests, burns, and dry open avalanche slopes with scrubby deciduous tree cover. The most important vegetation type is Douglas fir-ponderosa pine/wheatgrass (O24) open forests, usually on WY2.

WHITE-TAILED PTARMIGAN *Lagopus leucurus* WHPT

STATUS AND DISTRIBUTION

The White-tailed Ptarmigan is a resident of the mountains of western North America (Godfrey 1966).

During 1938 White-tailed Ptarmigan were found at Luxor Pass, Floe Lake, and Wolverine Pass (Munro and Cowan 1944).

The White-tailed Ptarmigan is an uncommon permanent resident of KNP. They have been found in high elevation locations throughout the park.

Broods of young with females have been recorded on several occasions in late July. Broods of up to five chicks have been seen at Tumbling Glacier and Numa Pass (naturalist files). A female with three young was near the Goodsir Pass trail in August 1983 (MMP).

HABITAT

The White-tailed Ptarmigan occurs in the Upper Subalpine and Alpine Ecoregions, where it frequents meadows, talus slopes and dryad tundra. In winter, flocks of ptarmigan occur on Upper Subalpine and Lower Subalpine avalanche slopes and floodplain meadows. Willow shrublands of HC1 are important wintering areas for this species. Based on data from circular bird census plots, the highest breeding season densities are on the following Ecosites: BP2 (.18), PL4 (.06), and RD2 (.01).

The most important vegetation types are: Engelmann spruce-subalpine fir/heather (O10) open forest (.10), subalpine larch-subalpine fir/heather (O13) open forest (.03), and mountain avens-snow willow-moss campion (H1) tundra (.01).

RUFFED GROUSE *Bonasa umbellus* RUGR

STATUS AND DISTRIBUTION

The Ruffed Grouse is found throughout the forested regions of Canada (Godfrey 1966)

The earliest reference to this species in KNP was a 1934 warden diary which stated that "Willow Grouse" were increasing their numbers in the Sinclair district. In June 1943 adults were seen at Dolly Varden Cr. and a female with two young were near McKay Cr. (Munro and Cowan 1944).

The Ruffed Grouse is a common permanent resident of KNP. Although less widespread than the Spruce Grouse, this species is the most frequently sighted grouse in the park. The Ruffed Grouse seems to be confined to the benchlands of the Columbia valley, the Sinclair Creek watershed, and the Kootenay valley, north as far as Mt. Wardle.

Broods have been recorded from Kimpton Cr., McKay Cr. and the Redstreak campground in the Sinclair drainage and also throughout the Kootenay valley in open areas near large ponds, campgrounds, meadows, and along fire roads (park wildlife cards).

The maximum number of drumming males recorded on spring migration surveys along the highway from Radium to Kootenay Crossing was six, on 11 May 1982 (MMP).

HABITAT

Ruffed Grouse are most abundant in mixed deciduous and coniferous forest on Montane alluvial fans and floodplains. They are infrequently seen on open Douglas fir slopes of the Columbia valley. All Ruffed Grouse recorded on circular bird census plots were on the following Montane Ecosites: WY1 (.15), and VL6 (.04).

The most important vegetation types are: Douglas fir/hairy wild rye (C1) closed forest (.06), and white spruce-Douglas fir/feathermoss (C5) closed forest (.02). There are very few winter observations of Ruffed Grouse but unidentified grouse tracks were recorded on WY1, VL6, FR1, FR3, AT1, AT4 and DR Ecosites.

SORA *Porzana carolina* SORA

STATUS AND DISTRIBUTION

In Canada, the Sora breeds from B.C. and the NWT east to the Atlantic provinces (Farrand 1983). Small populations occasionally winter in southwestern B.C. (Godfrey 1966).

The Sora is an uncommon summer resident of KNP. All records are from May to July in wetlands of the Kootenay valley. The earliest sightings were at Sora Pond and Settler's Road beaver ponds on 19 May 1982 (LRH). The latest record is of one in a small wetland along the East Kootenay fire road on 19 July 1983 (RMW).

There are no nest records but this species undoubtedly breeds at Dog Lake, Daer Pond, and Sora Pond and perhaps other areas of the Kootenay valley.

HABITAT

Soras occupy ponds and lakes in the Montane Ecoregion of KNP where there are extensive sedge meadows.

AMERICAN COOT *Fulica americana* COOT

STATUS AND DISTRIBUTION

The American Coot breeds across central and southern Canada. In B.C., it occurs throughout most of the province north to the Peace River district, and winters in the south (Godfrey 1966).

The American Coot is a locally common summer resident of KNP. It is restricted to ponds in the Kootenay valley. Spring migration is during April and May. The earliest record is of a single coot feeding on grasses by the side of the Highway 93 on 23 April 1982 (MMP, LRH). Autumn migration is during September and October. A coot was found on the switchbacks below Floe Lake on 12 September 1973 (GRS). Small numbers remained at Sora Pond until 7 October 1981. The maximum count is eight adults on Daer Pond on 12 May 1981 (LRH) and at Sora Pond on 10 May 1983 (RMW).

There are several breeding records from Sora Pond and one from Dog Lake. The earliest nest with eggs was recorded at Sora Pond on 29 May 1979 (LRH) and the earliest young on 21 June of the same year (LRH). At leat two pairs have nested on Sora Pond since 1980. A female with two young was observed on Dog Lake on 9 July 1981 (RMW).

American Coots are among the latest migrants in the Columbia valley, and small numbers winter in areas with open water (1981 Lake Windermere District Christmas bird count).

HABITAT

The American Coot occurs in lakes and ponds in the Montane Ecoregion. They nest and feed in shallow water with abundant emergent vegetation. Lawns, pastures and grassy roadside allowances are also used during migration.

KILLDEER *Charadrius vociferus* KILL

STATUS AND DISTRIBUTION

Killdeer are widely distributed throughout central and southern Canada. Small populations winter in southern B.C. (Godfrey 1966).

The Killdeer is a common summer resident of KNP. Spring migration is from late March to May. The earliest record is of one at the Kootenay River bridge on 13 March 1968 (park wildlife cards). Small numbers were counted along the lower Kootenay valley during spring migration surveys with a maximum of five observed on 3 June 1982 (MMP). There are two summer records from the Subalpine Ecoregion: an adult was seen near the headwaters of Helmet Creek on 23 July 1961 (Seel 1965) and a pair was recorded on circular bird census plots near Wolverine Cabin on 3 July 1983 (MMP). Autumn migration is in August and September with the latest record being two observed along the Kootenay River on 13 September 1982 (LRH). Killdeers are usually observed singly or in pairs throughout the Kootenay and Vermilion River watersheds.

Nests have been discovered at Kootenay Pond on 10 June 1981 and at Daer Pond on 13 May 1983 (RMW). Both nests contained four eggs. Pairs have been observed giving broken wing displays in several areas of the park. Killdeers have likely nested at Sora Pond and in several areas along the Kootenay and Vermilion rivers.

Small numbers of Killdeer are regularly seen in the Columbia valley during Christmas bird counts.

HABITAT

The Killdeer occurs in the Montane, Lower Subalpine and, occasionally, the Upper Subalpine Ecoregions of KNP. Preferred habitat includes gravel bars and shores of rivers, ponds, and lakes; disturbed areas near borrow pits; and wetlands and mudflats near water. Less frequently, Killdeer occur in wet sedge and willow meadows near subalpine streams.

GREATER YELLOWLEGS *Tringa melanoleuca* GRYE

STATUS AND DISTRIBUTION

The Greater Yellowlegs breeds from the Yukon and NWT through the prairie provinces of Canada to southern Hudson's Bay (Farrand 1983). In B.C., the species breeds locally in south-central regions of the province and a small population winters along the southwestern coast (Godfrey 1966).

The Greater Yellowlegs is considered a hypothetical species in KNP based on two unverified records from Kootenay Pond in 1965 (Seel 1965). One was reported on 27 May and two were reported on 19 August. Seel did not record the similar Lesser Yellowlegs, which is an uncommon migrant in KNP, especially at Kootenay Pond.

HABITAT

In KNP, Greater Yellowlegs have been reported twice from the shores of a pond in the Montane Ecoregion.

LESSER YELLOWLEGS *Tringa flavipes* LEYE

STATUS AND DISTRIBUTION

The Lesser Yellowlegs breeds through northwestern Canada, east to James Bay (Godfrey 1966).

It is an uncommon migrant in KNP. Spring migration occurs in May and June. The earliest record is on 13 May 1983; an individual seen at Daer Pond (MMP, RMW). On 14 May and 3 June 1982 a pair occurred at a small pond behind the Conservation Corps Camp (DMP). Autumn migration is during August. An early migrant was observed at Kootenay Pond on 31 July 1976 (naturalist files). Lesser Yellowlegs were observed in August of 1975 through 1977 at Kootenay Pond ((Van Tighem 1977)). Four were observed at a glacial subalpine lake in August 1975 (KVT), one was seen at the Paint Pots on 8 August 1976 (naturalist files), and two were recorded at Daer Pond on 30 August 1979 (LRH).

HABITAT

The Lesser Yellowlegs occurs in the Montane, Lower Subalpine and Upper Subalpine Ecoregions of KNP. Muddy or rocky shores of lakes and ponds, wetlands, and shallow waters of lakes with marshy vegetation are used by this species during migration.

SOLITARY SANDPIPER *Tringa solitaria* SOSA

STATUS AND DISTRIBUTION

The Solitary Sandpiper breeds from treeline in the Yukon and western NWT across central Canada to Labrador. It occurs throughout most of central B.C. (Godfrey 1966).

The Solitary Sandpiper is an uncommon summer resident in KNP. Spring migration occurs in May. The earliest record is an individual at Sora Pond on 10 May 1983 (RMW). Up to three Solitary Sandpipers have occurred during spring migration on ponds of the Kootenay valley. One was recorded along the Kootenay River on 1982 migration surveys. There are several summer records for the Kootenay valley. Solitary Sandpipers have been observed in several Upper Subalpine locations: along a creek in Goodsir Pass, at Floe Lake, and at small ponds in the wetlands of Ottertail Pass (park wildlife cards). Autumn migration is during August. Up to three have been seen at Kootenay Pond, Vermilion Crossing Pond, and the Redstreak sewage lagoon (naturalist files).

There is one definite breeding record: on 14 May 1982 a pair was first observed at a pond used as a water supply for the Conservation Corps Camp. They were observed throughout the summer and on 19 August had two young with them (MMP). Possible breeding pairs have been observed at Nixon Lake, Kootenay Pond and Dog Lake (park wildlife cards).

HABITAT

The Solitary Sandpiper is infrequently seen but widely distributed in the Montane, Lower Subalpine, and Upper Subalpine Ecoregions of KNP. It breeds near ponds and lakes with emergent sedge vegetation. Wet shrubby meadows, river floodplains and wet subalpine meadows are also used.

SPOTTED SANDPIPER *Actitis macularia* SPSA

STATUS AND DISTRIBUTION

The Spotted Sandpiper breeds from the arctic regions of Canada south to the southern U.S. The northern limit of its wintering grounds extends to the southwestern coast of B.C. (Godfrey 1966).

This species was first recorded in June 1943 from the upper reaches of Tokumm Cr. and the Kootenay River near Kootenay Crossing (Munro and Cowan 1944).

The Spotted Sandpiper is a common summer resident in KNP. It is the most common sandpiper and may be seen in all of the major drainages. The Spotted Sandpiper is commonest along the Kootenay and Vermilion rivers. Spring migration is during May and early June, and peaks during late May. The earliest sighting was an individual at Settler's Beaver Pond on 12 May 1982 (LRH). Four Spotted Sandpipers seen at Dog Lake represent the highest count during the spring period. Autumn migration is during August. The latest record is two along Numa Cr. on 20 August 1965 (Seel 1965). A maximum count of five Spotted Sandpipers was seen near the Stanley Glacier trailhead.

A nest was discovered at the north end of Dog Lake on 8 June 1973 (naturalist files). Two nests were found at Kaufmann Lake on 7 July 1983 (RMW). Adults with single young have been recorded from the Paint Pots, Tumbling Creek, Kootenay Pond, and Dog Lake (park wildlife cards). A late nest was found on 16 July 1978 along the lower Kootenay River (B.C. Prov. Museum Records).

HABITAT

The Spotted Sandpiper occurs from the Montane to the Upper Subalpine Ecoregion, along river floodplains, creeks, and lakes, ponds, and marshes. Preferred nesting habitat includes gravel bars and sedge meadows along rivers and lakeshores.

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=1.02), followed by the Upper Subalpine Ecoregion (DI=0.32). Ecosites on which the highest densities of this species occur are: HC1 (.41), AT4 (.29), VL2 (.17); and VL6 (.06).

The most important vegetation types are: willow-dwarf birch-shrubby cinquefoil (S10) shrublands (2.04), yellow dryad-willow herb (H8) meadows (1.02), Engelmann spruce-subalpine fir/willow/ribbed bog moss (O6) openforest (2.0), dwarf birch-shrubby cinquefoil-willow/brown moss (S1) shrublands (.15), and heather-everlasting (L5) heath meadows (.05).

WESTERN SANDPIPER *Calidris mauri* WESA

STATUS AND DISTRIBUTION

In North America, the Western Sandpiper breeds only along the western and northern coasts of Alaska. During migration, it is one of the dominant sandpipers along the Pacific coast (Farrand 1983).

The Western Sandpiper is hypothetical in KNP. There is an unverified record of an individual at Sora Pond in August 1977 (naturalist files).

There is a single record for this species during autumn migration in JNP (Holroyd and Van Tighem 1983). There are several reports of this species from YNP in the late summer (Wade 1977).

HABITAT

The record of a Western Sandpiper in KNP was from a pond in the Montane Ecoregion.

LEAST SANDPIPER ***Calidris minimus*** **LESA**

STATUS AND DISTRIBUTION

The Least Sandpiper breeds across subarctic Canada. It is a transient in most southern localities from coast to coast (Godfrey 1966).

The Least Sandpiper is a rare migrant in KNP. There is only a single record: four Least Sandpipers remained at Sora Pond for several days in mid-August 1977 (Van Tighem 1977).

The Least Sandpiper is a fairly common autumn migrant in JNP (Holroyd and Van Tighem 1983).

HABITAT

The only park record was along the marshy shores of a pond in the Montane Ecoregion.

BAIRD'S SANDPIPER ***Calidris bairdii*** **BASA**

STATUS AND DISTRIBUTION

Baird's Sandpiper breeds in the high arctic tundra of Canada. It occurs throughout the interior of B.C. during migration (Godfrey 1966).

The earliest park record of this species was in May 1945 when one was collected at Kootenay Crossing and placed in the U.B.C. Museum of Zoology. During the wildlife inventory a lone Baird's Sandpiper was observed feeding in shallow water at the north end of Daer Pond on 13 May 1983 (RMW, MMP).

Although the main population of this species migrates through the interior of western Canada, it will likely remain a very rare migrant in KNP. Only three records are known from BNP, and it is a very rare spring migrant in JNP (Holroyd and Van Tighem 1983).

HABITAT

In KNP, Baird's Sandpiper has occurred in shallow lakes and ponds with marshy vegetation in the Montane Ecoregion.

SHORT-BILLED DOWITCHER ***Limnodromus griseus*** **SHDO**

STATUS AND DISTRIBUTION

In Canada, the Short-billed Dowitcher breeds from southeastern Yukon across the northern prairie provinces to Hudson's Bay. Another population occurs in northern Quebec and Labrador. The range of the Short-billed Dowitcher also extends into the northwestern corner of B.C. and to the Peace River District (Godfrey 1966).

The Short-billed Dowitcher is hypothetical in KNP. A dowitcher, possibly of this species, was observed at Kootenay Pond in August 1977 (naturalist files).

The Short-billed Dowitcher is a very rare autumn migrant in BNP and JNP (Holroyd and Van Tighem 1983) . Both this species and the Long-billed Dowitcher have been recorded on migration in YNP (Wade 1977).

COMMON SNIPE *Gallinago gallinago* COSN

STATUS AND DISTRIBUTION

This holarctic species breeds throughout North America from Alaska to Labrador across Canada to the southern U.S. Snipe winter along the coast and in the southern interior of B.C. (Godfrey 1966).

The Common Snipe is an uncommon summer resident of KNP. They were recorded in the Kootenay valley during migration surveys throughout May in the Crook's Meadow and Dolly Varden Cr. area (MMP). A Snipe was heard winnowing over the Kootenay Crossing Pasture as early as 19 April 1983 (MMP). Autumn migration is from late August to mid-October. Five snipe were at Daer Pond on 30 August 1979, and an individual was feeding on the lawn of the Kootenay Crossing warden station on 15 October 1975 (park wildlife cards).

Nests have not yet been discovered, but summer records of up to three snipe have occurred at Sora Pond, Daer Pond, Dolly Varden Cr., and Sundew Pond (park wildlife cards). They are undoubtedly breeding in these areas.

Snipe overwinter in parts of the Rocky Mountain Trench where warm-springs maintain areas of open water (1983 Cranbrook Christmas bird count).

HABITAT

Common Snipe breed along the marshy edges of ponds and lakes and in shrubby wetlands in the Montane Ecoregion of KNP. It is commonest along Dolly Varden Cr. in open spruce wetlands dominated by Labrador tea and brown moss (DR6, O11).

WILSON'S PHALAROPE *Phalaropus tricolor* WIPH

STATUS AND DISTRIBUTION

In Canada, Wilson's Phalaropes breed in the western provinces from the southern Yukon and south-central interior of B.C., across the prairies to Manitoba (Godfrey 1966).

Although Wilson's Phalarope may breed in the Columbia valley adjacent to KNP, they remain rare migrants within the park. There are only three records; one from spring and two from autumn. A female was swimming on Dog Lake on 16 May 1977 (Van Tighem 1977). Wilson's Phalaropes were recorded from Nixon Lake and Dog Lake during autumn migration in mid-September 1980 (naturalist files).

HABITAT

Wilson's Phalaropes have occurred in lakes and ponds in the Montane Ecoregion during migration.

RED-NECKED PHALAROPE *Phalaropus lobatus* NOPH

STATUS AND DISTRIBUTION

The Red-necked Phalarope breeds in the low arctic and subarctic regions of North America. Red-necked Phalaropes occur off the Pacific Coast of B.C. during migration (Farrand 1983). The species is a rare migrant in the Rocky Mountains.

The Red-necked Phalarope is a rare migrant in KNP. There are two spring and three autumn records, four of which were in the Kootenay valley. A pair was observed on Daer Pond on 12 May 1981 (LRH) and a female and two males were seen on Kootenay Pond on 30 May 1982 (MMP). One was seen at Dog Lake in August 1975 and a pair visited Kootenay Pond on 19 August 1977 (naturalist files). There is one record from the upper Vermilion valley; six were seen on a small lake on the side of Storm Mountain on 22 August 1976 (naturalist files).

HABITAT

The Red-necked Phalarope occurs primarily in the Montane Ecoregion of KNP in ponds and lakes. There is one autumn record from a lake in the Upper Subalpine Ecoregion.

LONG-TAILED JAEGER *Stercorarius longicaudus* LOJA

STATUS AND DISTRIBUTION

The Long-tailed Jaeger is circumpolar, breeding throughout arctic regions of the Northern Hemisphere. In Canada it breeds from the northern Yukon to the Ellesmere Islands (Godfrey 1966).

Two records exist for this species in KNP: one was seen crossing the Main Ranges near Vermilion Pass on 18 September 1911 (Brooks and Swarth 1925) and an adult bird was found dead on Highway 93 one mile south of Kootenay Crossing by a park warden on 29 September 1975. These are exceptional records for KNP and the status for this species will no doubt remain as "accidental".

Two records for the Long-tailed Jaeger are available from JNP during the summer of 1976 (Holroyd and Van Tighem 1983).

BONAPARTE'S GULL *Larus philadelphia* BOGU

STATUS AND DISTRIBUTION

Bonaparte's Gull ranges across the boreal forest of northwestern Canada from the Yukon east to James Bay. In B.C., it breeds in the interior and winters along the southern coast (Godfrey 1966).

Bonaparte's Gull is a rare migrant in KNP. There are two records from both spring and autumn migration. The first park record is one at Kootenay Pond on 27 May 1965 ((Seel 1965)). One landed on Highway 93 south of the Paint Pots on 15 May 1977 (park wildlife cards). Autumn records include an immature at Kootenay Pond on 28 August 1980 and an adult at Daer Pond on 26 October 1981 (LRH).

HABITAT

Bonaparte's Gull has occurred at lakes and ponds in the Montane Ecoregion.

SABINE'S GULL *Xema sabini* SAGU

STATUS AND DISTRIBUTION

Sabine's Gull breeds on arctic coasts and islands from Spitzbergen through Greenland, arctic Canada, Alaska to Siberia. In B.C., it is a regular fall migrant on the coast, but rare in the interior (Godfrey 1966).

This species is of accidental occurrence in KNP. The only record is of an immature killed on Highway 93 near the Kootenay River picnic site during the summer of 1975 (BRS).

Five records are known from JNP and one record from BNP. Sabine's Gull is considered a very rare migrant and summer visitor to the mountain parks (Holroyd and Van Tighem 1983).

HABITAT

The Sabine's Gull record for KNP was from the Kootenay River floodplain in the Montane Ecoregion.

RING-BILLED GULL *Larus delawarensis* RIGU

STATUS AND DISTRIBUTION

The Ring-billed Gull breeds throughout the prairie provinces of Canada and in limited areas around the Great Lakes and Atlantic coast. It occurs in the southern interior of B.C. during the summer, and winters in the southwest (Godfrey 1966).

The Ring-billed Gull is a rare migrant and summer visitor to KNP. There are five records, four during the summer and one on autumn migration. Three summer records are from along the Kootenay and Vermilion rivers: one immature near Simpson's Monument on 16 July 1970, four near McLeod Meadows on 29 July 1975, and two near the Conservation Corps camp on 14 July 1981 (park wildlife cards). Another occurred at a glacial lake near Wolverine Pass on 24 July 1982 (MMP). The autumn record is also from the Upper Subalpine; two were observed at Floe Lake on 28 August 1976 (KVT).

HABITAT

Ring-billed Gulls occur along rivers in the Montane and Lower Subalpine Ecoregions. They occur less frequently on lakes in the Upper Subalpine Ecoregions of the park.

CALIFORNIA GULL *Larus californicus* CAGU

STATUS AND DISTRIBUTION

In Canada, the California Gull breeds from Great Slave Lake south through the prairie provinces. It migrates through the interior of B.C. and winters along the southern coast (Godfrey 1966).

A rare visitor to KNP, the California Gull occurs in small numbers during migration and through the summer. During May 1976, an immature California Gull was seen at Kootenay Pond (Van Tighem 1977). During the summer of 1965, adults and immature gulls were sighted at the Paint Pots, Kootenay Pond and Radium Hot Springs (Seel 1965).

A maximum count of three California Gulls was obtained at Marble Canyon during autumn migration on 28 August 1976 (Van Tighem 1977).

HABITAT

California Gulls have occurred in the Montane and Lower Subalpine Ecoregions at ponds and along rivers in the Kootenay valley and Vermilion valley.

ROCK DOVE *Columba livia* RODO

STATUS AND DISTRIBUTION

An introduced species from Eurasia, the Rock Dove occurs throughout inhabited regions of North America (Godfrey 1966).

The Rock Dove is a rare summer visitor to KNP. Since 1970, Rock Doves have been observed along Highway 93 in the Kootenay valley and Vermilion valley. Solitary doves were near Marble Canyon on 23 April 1981 and at Kootenay Crossing on 8 May 1980 (park wildlife cards). One Rock Dove was seen near Hawk Cr. in mid-August 1970 (naturalist files).

Rock Doves are permanent residents of the townsites of BNP and JNP (Holroyd and Van Tighem 1983). They are also listed as residents of the Wilmer Wildlife Area in the Columbia valley (Simpson and Kelsall 1978).

HABITAT

Rock Doves inhabit cities, towns and farmlands. In KNP they occur in disturbed areas such as campgrounds and warden stations, or along Highway 93.

MOURNING DOVE *Zenaida macroura* MODO

STATUS AND DISTRIBUTION

The Mourning Dove breeds throughout southern Canada (Godfrey 1966). In B.C., it occurs in the southern interior and along the coast to Alaska (Farrand 1983).

The Mourning Dove is an uncommon migrant in KNP. Since 1966 all but one of 25 records have occurred during spring migration. The earliest arrival date is 23 April 1981 for an individual at Numa Flats (naturalist records). Sightings peak in mid-May and by early June Mourning Doves are no longer seen in the park. Most records are of solitary doves or pairs along Highway 93 in the Kootenay valley and Vermilion valley. One flock of five Mourning Doves was seen at McLeod Meadows on 10 May 1983 (RMW). One record is available for autumn migration; on 3 August 1977 an individual was seem at the Numa Picnic Site (Van Tighem 1977).

Mourning Doves nest in the Columbia valley adjacent to the park.

HABITAT

During migration, the Mourning Dove is primarily seen along Highway 93 in the Montane and Lower Subalpine Ecoregions. Open areas formed by ponds, meadows, pastures and river floodplains are preferred. Mourning Doves also occur around disturbed sites in coniferous forest and alluvial fans with deciduous and mixed forest.

FLAMMULATED OWL *Otus flammeolus* FLOW

STATUS AND DISTRIBUTION

The Flammulated Owl breeds locally in southern B.C. east to the Rocky Mountains (Godfrey 1966).

A fledgling, possibly of this species, was discovered near the McKay Cr. compound on 27 July 1975 (Van Tighem 1977). At present the Flammulated Owl is hypothetical in KNP. It is rare over most of its range in B.C. A single hoot of this species was heard near Steamboat Lake in the Columbia River valley on 18 May 1983 (RMW, MMP).

HABITAT

This species occurs primarily in the Montane Ecoregion, In B.C. it prefers coniferous forest where there are openings in the tree canopy. The single KNP record was in Douglas fir-white birch woodland.

WESTERN SCREECH-OWL *Otus kennicottii* SCOW

STATUS AND DISTRIBUTION

The Western Screech-Owl occurs across the United States and ranges north into the southern Canada. In B.C., it occurs along the coastline to southeastern Alaska, and across the south-central regions of the province (Godfrey 1966).

The Western Screech-Owl is accidental for KNP. One was heard near the Mt. Shanks fire road on a circular bird census plot in June 1983 (RMW).

It is listed as a summer resident for the Wilmer Wildlife Area (Simpson and Kelsall 1978).

HABITAT

The Western Screech-Owl normally occurs in the Montane Ecoregion in open deciduous forest. The individual in KNP was found in closed spruce-fir forest in the Lower Subalpine Ecoregion. This represents an atypical habitat for this species and further park records are unlikely.

GREAT HORNED OWL *Bubo virginianus* GHOW

STATUS AND DISTRIBUTION

The Great Horned Owl has an extensive distribution over much of Canada. It is found throughout most of B.C. north to treeline in the Yukon and NWT (Godfrey 1966).

Thirty-six Great Horned Owls were destroyed in KNP from 1932 to 1935 (warden records). One flew across Highway 93 near Hawk Cr. in June 1943 (Munro and Cowan 1944).

The Great Horned Owl is an uncommon permanent resident of KNP. A roadkill was collected in the Sinclair Cr. canyon in March 1978, and others have been recorded near Dog Lake, Kootenay Viewpoint, Radium Lodge, and Settler's Road (naturalist files).

Great Horned Owls nest within KNP; an adult pair with two fledged young were discovered near the McKay Cr. compound in July 1972 (naturalist files).

During spring 1982 owl surveys a pair was heard calling to each other near Kootenay Crossing on a regular basis. No more than two Great Horned Owls per night were heard on these surveys.

HABITAT

This species occurs primarily in the Montane Ecoregion. It prefers mixed deciduous and coniferous forest near open areas created by fields and ponds. In KNP, Great Horned Owls may be found on alluvial fans within Ecosites VL2 and AT1.

NORTHERN HAWK-OWL *Surnia ulula* HAOW

STATUS AND DISTRIBUTION

The Northern Hawk-Owl breeds in northern coniferous forests across Canada, north to treeline. It occasionally ranges south to the northern U.S.A. during the winter (Godfrey 1966). Northern Hawk-Owls are known to occur in the Columbia valley in burned forest adjacent to Lake Windermere and near Toby Cr. (LRH, MMP). They have been recorded on several occasions during Lake Windermere District Christmas bird counts.

The Northern Hawk-Owl is a rare permanent resident of KNP. The first record was in 1972 when one was seen near McLeod Meadows (IDJ). They have been consistently sighted in the vicinity of the Vermilion Pass burn since 1975. Winter sightings occurred near Helmet Cabin in 1976 and Wolverine Pass in 1977 (park wildlife cards). Recent observations include a sighting in the Chickadee valley (headwaters of the Vermilion River)at the northern boundary of KNP during February 1983 (LRH).

Northern Hawk-Owls breed in KNP, with a record of fledged young from the Vermilion Pass burn in 1975 (Van Tighem 1977).

HABITAT

This species occurs primarily in the Subalpine Ecoregion, and infrequently in the Montane Ecoregion of KNP. In KNP, they prefer recent burns of spruce fir forest, and open subalpine coniferous forest.

NORTHERN PYGMY-OWL *Glaucidium gnoma* PYOW

STATUS AND DISTRIBUTION

The Northern Pygmy-Owl is restricted to western Canada, with a breeding range extending from the Pacific Coast to the Rocky Mountains in B.C. It ranges north to southeastern Alaska and south to Guatemala (Godfrey 1966).

The first park record was near the administration building in January 1974 (IDJ). In 1976 and 1977 Northern Pygmy-Owls were detected at Dog Lake, Daer Pond, Numa Creek Trail and north of McLeod Meadows (Van Tighem 1977).

The Northern Pygmy-Owl is an uncommon permanent resident of KNP. It is the most commonly encountered owl in the Columbia River valley (MMP). Spring owl surveys conducted in KNP from March to May revealed a maximum of three Northern Pygmy-Owls for a single night in both 1982 and 1983. They were found to have a wide distribution in the park from the Redstreak campground, through the Sinclair Cr. drainage and throughout the Kootenay River valley to Kootenay Crossing. An individual was calling above Verendrye Cr. during summer breeding bird surveys.

Northern Pygmy-Owls undoubtedly breed in KNP, but nesting sites have remained undetected. An adult flew into a tree cavity near Wilmer in the Columbia River valley in April 1982, and nest sites have been documented for BNP (Holroyd and Van Tighem 1983).

HABITAT

The Northern Pygmy-Owl is found primarily in the Montane and Subalpine Ecoregions, in closed coniferous and mixed forest with openings in the canopy.

BARRED OWL ***Strix varia*** **BAOW**

STATUS AND DISTRIBUTION

The Barred Owl breeds from the Yukon border across south-central Canada to the Atlantic coast (Godfrey 1966). This species may be expanding its range in B.C. and adjacent areas (Boxall and Stepney 1982).

The first record in the vicinity of KNP was a Barred Owl three miles south of the park boundary (IDJ). Several owls were seen in the Sinclair Cr. canyon, and another near Dog Lake in the mid 1970's. (Van Tighem 1977).

Barred Owls are rare permanent residents of KNP. An adult with two fledged young was seen near the McKay Cr. compound in 1975 (KVT), and again in 1981 (RMW). During the inventory Barred Owls were recorded in the Kootenay River valley and the Columbia River valley. A roadkill was collected near Kootenay Crossing in 1983. During spring owl surveys, two were heard near the Kootenay Crossing horse pasture, and one consistently called on the slopes above Radium in 1982 and 1983 (MMP).

HABITAT

The Barred Owl occurs in mixed deciduous coniferous forest near openings created by lake edges, or meadows. This habitat is commonly found along stream or river floodplains. In KNP, Barred Owls are restricted to the Montane Ecoregion. They have nested in Douglas fir-aspen-white birch forest near McKay Cr. At other locations within the park they have occurred in open Douglas fir forest, wet white spruce forest, and mixed spruce-pine forest. Outside the park it is common in riparian poplar forest along the Columbia River.

GREAT GRAY OWL ***Strix nebulosa*** **GGOW**

STATUS AND DISTRIBUTION

The Great Gray Owl ranges across Canada from treeline in the Yukon to Quebec, within the northern coniferous forest. Southern movements occur periodically during winter months (Godfrey 1966).

A rare permanent resident in KNP, the Great Gray Owl has been infrequently sighted since 1975. A roadkill was taken near the East Kootenay fire road in 1981 (naturalist files). The highest count during spring owl surveys was one, just south of Kootenay Crossing.

A single nest record exists for KNP: two young were raised in an abandoned Red-tailed Hawk nest near Crook's Meadow in 1975 (Van Tighem 1977). Fledged young have been sighted in the vicinity of the Vermilion Pass burn (warden records).

HABITAT

The Great Gray Owl occurs in the Montane and Lower Subalpine Ecoregions in coniferous or deciduous forest.

SHORT-EARED OWL ***Asio flammeus*** **SHOW**

STATUS AND DISTRIBUTION

The Short-eared Owl ranges through most of Canada. In B.C., Short-eared Owls migrate from northern regions to winter along the southwestern coast (Godfrey 1966).

The Short-eared Owl is a rare migrant in KNP. There are only three records. A roadkilled Short-eared Owl near Marble Canyon on 16 July 1970 (naturalist files) constitutes the first park record. The other two records are from late Autumn. One was observed catching a microtine near Settler's Road on 1 November 1974 (IDJ) and one was seen in the Kootenay valley near Dolly Varden picnic site on 5 October 1981 (DMP).

This species is listed as an occasional visitor to the Wilmer Wildlife Area (Simpson and Kelsall 1978). Short-eared Owls are observed in the Columbia valley during migration and have occurred near Columbia Lake in late November (Wilson 1971).

The Short-eared Owl is not known to breed in the Rocky Mountains (Salt and Salt 1976).

HABITAT

During the BNP and JNP inventory, Short-eared Owls occurred primarily in the Montane Ecoregion with some records from the Subalpine and Alpine Ecoregions. Preferred habitats were grasslands and shrub wetlands on alluvial landforms (Holroyd and Van Tighem 1983). In KNP, the Short-eared Owl has occurred in the Montane and Lower Subalpine Ecoregions. All records for the park occurred along the grassy edge of Highway 93.

BOREAL OWL ***Aegolius funereus*** **BOOW**

STATUS AND DISTRIBUTION

The Boreal Owl occurs across north-central Canada from Alaska to Newfoundland. It is resident in most of its range but periodically migrates south as far as the northern U.S.A. (Godfrey 1966).

The Boreal Owl is an uncommon permanent resident of KNP. The earliest park records are of Boreal Owls heard calling near the head of Numa Cr. in June 1975 and near Numa Cr. picnic site in July 1975 (Van Tighem 1977). During the inventory it was found to be more common and widespread than previously believed. It occurs throughout the Kootenay River valley from the forested slopes above the Kootenay River picnic site to the Conservation Corps Camp, McLeod Meadows, Mt. Harkin, Kootenay River flats, Dolly Varden Cr., East Kootenay fire road and the Airport Meadows. Several were present at Kootenay Crossing, one near the Kootenay River and another in the coniferous forest near the highway. The maximum number of Boreal Owls heard on an owl survey was six. A single owl was calling from the subalpine forest above Helmet Cabin in March 1983.

Breeding records have not yet been obtained for this species but it undoubtedly nests in KNP. Boreal Owls breed in BNP and JNP (Holroyd and Van Tighem 1983).

HABITAT

The Boreal Owl is found in the Montane and Lower Subalpine Ecoregions in closed coniferous forest. It prefers spruce-fir forest with adjacent meadows.

NORTHERN SAW-WHET OWL *Aegolius acadicus* SAOW

STATUS AND DISTRIBUTION

The breeding range of the Northern Saw-whet Owl extends across southern Canada. In B.C., it occurs north to the Queen Charlotte Islands and extreme southeast Alaska. Southern movements during winter may take these owls to Central America (Godfrey 1966).

The Northern Saw-whet Owl is a rare permanent resident of KNP. The only record is one heard calling near McLeod Meadows on 19 April 1982 during an owl survey (MMP).

The Northern Saw-whet Owl is listed as a resident of the Wilmer Wildlife Area in the Columbia River valley (Simpson and Kelsall 1978). Northern Saw-whet Owls are known to occur in BNP, where nesting records exist for the lower Bow River valley (Holroyd and Van Tighem 1983).

HABITAT

This species occurs primarily in the Montane Ecoregion in moist deciduous or mixed forest.

COMMON NIGHTHAWK *Chordeiles minor* CONI

STATUS AND DISTRIBUTION

The Common Nighthawk occurs throughout B.C. and southern Canada (Godfrey 1966).

Munro and Cowan (1944) called it a "summer visitant in the open region of the park from Kootenay Crossing south".

The Common Nighthawk is an uncommon summer resident most often seen in the southern regions of the park. There are two nest records, both near Redstreak campground. On 4 August 1970 a nest with two eggs was found near Stoddart Cr. (naturalist files) and on 5 July 1977 two downy young were found (KVT).

The Common Nighthawk is a late migrant, the earliest observation being on 11 June 1973 and the latest on 4 September 1965 (naturalist files).

HABITAT

This species is most commonly seen in the Douglas fir open forest (O5) near Redstreak campground (Van Tighem 1977). Common Nighthawks have also been seen along the river flats of the Kootenay and Vermilion rivers (HD6, H8). All records have come from the Montane Ecoregion.

BLACK SWIFT *Cypseloides niger* BLSW

STATUS AND DISTRIBUTION

The Black Swift occurs in northwestern and southern B.C. and southwestern Alberta (Godfrey 1966).

Munro and Cowan (1944) reported a pair from Vermilion Crossing.

The Black Swift is an uncommon and local summer resident of the park. They are most often seen above Marble Canyon and probably breed there. They are also seen at Helmet Falls, Sinclair Canyon, and occasionally in the river lowland areas. Black Swifts are late arrivals, the earliest being reported on 15 June 1983 (RMW).

No nests have been found in KNP, however the species nests in Johnson's Canyon, BNP ((Holroyd and Van Tighem 1983)).

HABITAT

The Black Swift often forages over mountain valleys at great heights. In poor weather conditions they are likely to be found much lower (Godfrey 1966). The species uses the walls of moist canyons for nesting.

VAUX'S SWIFT ***Chaetura vauxi*** **VASW**

STATUS AND DISTRIBUTION

Vaux's Swift occurs along the northwest coast and throughout the southern parts of B.C. (Godfrey 1966).

The Vaux's Swift is a rare summer visitor to KNP from the Columbia valley. There are only two records for the park. An unusual record of six birds near Marble Canyon on 31 August 1972 may have been of Black Swifts. Three Vaux's Swifts were seen by several of the inventory staff on 26 May 1983 at Nipika.

The species is seen commonly near Radium Hot Springs townsite just outside the park boundary (RMW).

HABITAT

This species occurs in a wide variety of habitats. It is commonly seen flying low over water, forest openings, burns, and river valleys (Godfrey 1966). It often forages near dusk over water in the Columbia valley (RMW).

BLACK-CHINNED HUMMINGBIRD ***Archilochus alexandri*** **BLHU**

STATUS AND DISTRIBUTION

The Black-chinned Hummingbird occurs in Canada only in some of the drier southern B.C. valleys(Godfrey 1966).

There is one unverified sighting of a female near Radium on 9 August 1965 (Seel 1965).

The species has been rarely observed in the Columbia valley outside the park boundaries and would not normally be expected to occur in KNP.

HABITAT

The Black-chinned Hummingbird is commonest in riparian woodlands in arid areas.

CALLIOPE HUMMINGBIRD ***Stellula calliope*** **CAHU**

STATUS AND DISTRIBUTION

The Calliope Hummingbird occurs in the mountains of central B.C. to southwestern Alberta (Godfrey 1966). The Calliope Hummingbird is a rare summer resident in Banff, Jasper, and Yoho National Parks.

The Calliope Hummingbird is a rare summer resident in the park. The four observations are from very scattered localities. A nest containing two eggs was found at Marble Canyon on 15 July 1975 (KVT). This species was first recorded in KNP on 1 August 1965 (Naturalist files).

HABITAT

The Calliope Hummingbird is a mountain species which inhabits openings in many forest types, avalanche slopes, burns, and other types of flowery meadows (Godfrey 1966). Two were seen in the Montane and two in the Lower Subalpine Ecoregion. They were seen in burn vegetation (S5), wet shrubland (S1) and disturbed sites.

RUFOUS HUMMINGBIRD *Selasphorus rufus* RUHU

STATUS AND DISTRIBUTION

The Rufous Hummingbird occurs throughout B.C. except for the northeastern corner. It can also be found in the mountains and foothills of southwestern Alberta (Godfrey 1966).

Cowan and Munro found this species from Sinclair Canyon to Vermilion Crossing in June 1943.

The Rufous Hummingbird is common and widespread in open areas throughout KNP. This species arrives near the middle of May and departs before the end of August. It undoubtedly breeds since males have frequently been seen displaying during the breeding season and a female was observed collecting nesting material near Verendrye Cr. on 1 June 1983 (RMW). A total of 23 was recorded on 605 circular bird plots.

HABITAT

This species occurs from valley bottom to timberline, especially in open areas where shrubs and forbs abound. As the summer progresses the Rufous Hummingbird often moves upwards in elevation following the blooming wildflowers.

The highest density, based on circular bird census plot samples, is in the Upper Subalpine Ecoregion (DI=.15), followed by the Montane Ecoregion (DI=.09). Ecosites on which the highest densities of this species occur are: BY1 (.69), DR6 (.57), and FR3 (.51).

The most important vegetation types are: green alder/fern (S13) avalanche shrub (2.25), white spruce/buffaloberry/feathermoss (C37) closed forest (.57), and spruce-aspen-lodgepole pine (paper birch)/buffaloberry/pine grass (C44) closed forest (.30).

BELTED KINGFISHER *Megaceryle alcyon* BEKI

STATUS AND DISTRIBUTION

The Belted Kingfisher occurs throughout B.C. and southern Canada (Godfrey 1966). Munro and Cowan (1944) found a pair nesting along the Kootenay River.

The Belted Kingfisher is an uncommon summer resident of KNP. It is most often observed in the Kootenay valley but has also been found in the Vermilion valley. Munro and Cowan's observation constitutes the only breeding record for the park. A total of three was recorded on 605 circular bird plots.

HABITAT

The Belted Kingfisher is found most commonly along streams and ponds in the Montane Ecoregion although there are three records from the Lower Subalpine. The species prefers clear water where fish are plentiful and good perches are available (Godfrey 1966).

YELLOW-BELLIED SAPSUCKER *Sphyrapicus varius* YESA

STATUS AND DISTRIBUTION

The Yellow-bellied Sapsucker ranges from the southern Yukon and NWT through the Rocky Mountains and across southcentral Canada to southern Labrador and Newfoundland. Wintering grounds are from the southern breeding range to Central America (Farrand 1983).

The Yellow-bellied Sapsucker is a common summer resident of KNP. It was first recorded near Kootenay Crossing in 1943 (Munro and Cowan 1944). The Yellow-bellied Sapsucker occurs primarily in the mixed montane forest of the Kootenay valley with sightings from the Redstreak area adjacent to the Columbia valley, and one record from the lower Vermilion valley (park wildlife cards). A total of 16 was recorded on 605 circular bird plots.

Spring migration is in May with the earliest record on 28 April 1983 at Kootenay Pond (MMP).

Of eight nest records, seven nests were located in live aspen trees near Dog Lake, Nixon Lake, and Crook's Meadow (park wildlife cards) and one occurred in a white birch near the Simpson slidepaths (Van Tighem 1977).

Autumn migration is during August. A group of three Yellow-bellied Sapsuckers remained until at least 28 August 1973 along the Dog Lake trail (naturalist files).

HABITAT

The Yellow-bellied Sapsucker typically inhabits mixed woodlands with aspen stands, and mixed forest edges.

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=0.04). Ecosites on which the highest densities of this species occur are: DR6(.36) and FR3(.16).

The most important vegetation types are: spruce-aspen-lodgepole pine (paper birch)/buffaloberry/pine grass (C44) closed forest (.10) and spruce/Labrador tea/brown moss (O11) open forest (.09).

DOWNY WOODPECKER *Picoides pubescens* DOWO

STATUS AND DISTRIBUTION

The Downy Woodpecker ranges across Canada north to southern Yukon and Mackenzie District. It may abandon high mountains and the northern limits of its range during the winter (Farrand 1983)

The Downy Woodpecker is a rare permanent resident in KNP and is the least common of KNP's resident woodpeckers. They were initially observed during the winter of 1965 when a female visited a feeder near the Redstreak campground (Seel 1965). All subsequent records have occurred in the Montane forest of the lower Kootenay valley at Dolly Varden Cr., Crook's Meadow and along the Dog Lake trail (park wildlife cards).

They are regularly included in Lake Windermere District Christmas bird counts in the Columbia valley. Several nest records have been found in the lower Bow River valley in BNP (Holroyd and Van Tighem 1983) . A total of three was recorded on 605 circular bird plots.

HABITAT

In KNP, the Downy Woodpecker usually inhabits the mixed (C44) forest of the Kootenay valley. It has also occurred at a feeder in the Douglas fir (05) open forest in the Redstreak area.

HAIRY WOODPECKER *Picoides villosus* HAWO

STATUS AND DISTRIBUTION

The Hairy Woodpecker ranges from treeline in northern Canada through the U.S. to Mexico (Farrand 1983).

This species is an uncommon permanent resident of KNP. Sightings have been concentrated in the Montane forest of the Kootenay valley near ponds and wetland areas (park wildlife cards). They occur in the Redstreak area and adjacent Columbia valley and sparsly in the Vermilion valley along the Vermilion Pass Burn (park wildlife cards). One record is known from the Upper Subalpine; a male at Goodsir Pass in March 1983 (MMP).

Of nine nest records for this species two occurred at the McKay Cr. Compound, and seven were in live aspen trees along the lower Kootenay River from Kootenay Crossing to the Cross River fire road (KVT, MMP, RMW). A total of 16 was recorded on 605 circular bird plots.

HABITAT

The Hairy Woodpecker prefers mixed forest on alluvial landforms containing stands of trembling aspen. It also occurs in open and closed Douglas fir forest, and open spruce forest near shrubby wetlands.

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=0.07), followed by the Lower Subalpine Ecoregion (DI=0.03). Ecosites on which the highest densities of this species occur are: WY1(.22), VL6(.18), DR6(.17), DG1(.17), BY4(.11), and FR1(.05).

The most important vegetation types are: aspen/hairy wild rye-peavine (C16) closed forest(.50), Douglas fir/hairy wild rye (C1) closed forest (.50), spruce/Labrador tea/brown moss (O11) open forest(.11), spruce-aspen-lodgepole pine (paper birch)/buffaloberry/pine grass (C44) closed forest (.10), and Douglas fir/juniper/bearberry (O5) open forest (.07).

MANAGEMENT CONSIDERATIONS

The Hairy Woodpecker is a "Blue List" species in North America although its population is not considered threatened in B.C. (Tate 1982).

THREE-TOED WOODPECKER *Picoides tridactylus* NOWO

STATUS AND DISTRIBUTION

The Three-toed Woodpecker is found in northern regions of North America. It breeds through forested regions of Canada north to treeline (Godfrey 1966).

In 1943 the Three-toed Woodpecker was considered "the most common woodpecker" in KNP (Munro and Cowan 1944).

It is the most widespread of the woodpeckers in KNP, occurring in all major river and creek drainages and is a common permanent resident of the park.

Males initiate territorial drumming by mid-March. By late April numbers had peaked to ten males along the spring migration survey route from the Sinclair Pass area through the lower Kootenay valley.

Nests discovered during the wildlife inventory were located in spruce trees along the Kindersley Cr. trail and in the Ottertail valley in June 1983, in a spruce along the Tumbling Cr. trail in July 1983 (MMP), and from near the Daer fire road on 22 June 1983 (RMW). Fledged young were recorded from Daer Pond, Verendrye Cr., and the Vermilion Pass burn. A total of 14 was recorded on 605 circular bird plots.

HABITAT

The Three-toed Woodpecker prefers mature coniferous forest composed of white spruce and Douglas fir, and subalpine forest dominated by Engelmann spruce and subalpine fir. They are also found in open larch forests, such as those at Goodsir Pass, Ottertail Pass, and upper Tokumm Cr. (RMW, MMP).

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=10.01), followed by the Lower Subalpine Ecoregion (DI=0.01). Ecosites on which the highest densities of this species occur are: CV1(.09), DR7(.09), EG3(.08), CA2(.05), DR6(.05), PL1(.05), and BY7(.04).

The most important vegetation types are: white spruce-western larch-Douglas fir/bunchberry (C45) closed forest (.23), Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4) open forest (.18), Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) closed forest (.05), lodgepole pine/false azalea/grouseberry (C20) closed forest (.04), and Engelmann spruce-subalpine fir/false azalea (C14) closed forest (.02).

BLACK-BACKED WOODPECKER *Picoides arcticus* BLWO

STATUS AND DISTRIBUTION

In Canada the Black-backed Woodpecker is resident from the southern Yukon and NWT across forested regions of southcentral Canada to Labrador and Newfoundland. It occurs throughout the interior and Rocky Mountains of B.C. (Godfrey 1966).

The Black-backed Woodpecker is a rare permanent resident of KNP. It was initially recorded in the Kootenay valley in 1943 (Munro and Cowan 1944). Although a breeding resident of KNP, it has been infrequently sighted since that time. They have been seen in the Redstreak area and in the lower Kootenay valley at Swede Creek, Cobb Lake trail, Daer Pond, and Dog Lake (park wildlife cards). In the Vermilion valley, Black-backed Woodpeckers were found in the Vermilion Pass burn during the summer of 1973, and there were three near the Shanks fire road in the winter of 1980 (RMW). There are two breeding records; a pair with two young in a dead Engelmann spruce near the Marble Canyon trail during the summer of 1963 (Seel 1965) and a family group, including at least two fledged young, near Redstreak on 10 July 1981 (RMW).

HABITAT

Black-backed Woodpeckers are inhabitants of coniferous forest in the Montane and Lower Subalpine Ecoregions. Closed spruce-fir forest is preferred, as well as Douglas fir forest and, occasionally, burned forest.

During winter track count transects, Black-backed Woodpeckers were recorded in the Montane Ecoregion on DR3 and FR3 in white spruce/buffaloberry/feathermoss (C37) closed forest and spruce/Labrador tea/brown moss (O11) open forest.

NORTHERN FLICKER *Colaptes auratus* COFL

STATUS AND DISTRIBUTION

The Northern Flicker breeds throughout forested regions of Canada, and migrates to southern and coastal regions in winter. The Redshafted subspecies (*C.a.cafer*) is the predominant flicker west of the Rocky Mountains in B.C. (Godfrey 1966).

The Northern Flicker is a common summer resident of the Columbia valley and Kootenay valley. Nests have been recorded since June 1943 when they were found at Crook's Meadow and Kootenay Crossing (Munro and Cowan 1944).

Spring migration is during April and May. A maximum count of 28 was recorded in late April 1982 during spring migration surveys.

Of six recent nest records, four were located in the vicinity of the Kootenay Crossing ponds. A Northern Flicker nested in the garage of the Kootenay Crossing warden station in the summer of 1982 (MMP). Fledged young were seen in the Vermilion Pass burn in July 1982 and 1983 and a nest was located in the burn along Dog Lake in July 1981 (RMW).

Autumn migration is from late August to October. On 8 December 1981, a male Northern Flicker was at the Sinclair warden station ,feeding on the ornamental trees (MMP). They are regularly included in the Lake Windermere District Christmas bird count. A total of 41 was recorded on 605 circular bird plots.

HABITAT

The Northern Flicker occurs primarily in the mixed forest, and open spruce forest associated with wetlands of the Montane Ecoregion of the Kootenay valley. They are also common in burned forests of the Lower Subalpine Ecoregion.

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=0.01), followed by the Lower Subalpine Ecoregion (DI=0.01). Ecosites on which the highest densities of this species occur are: FR3(.06), FR1(.05), BY3(.05), CV1(.03), and VL6(.02).

The most important vegetation types are: spruce/Labrador tea/brown moss (O11) open forest (.07), spruce-aspen-lodgepole pine (paper birch)/buffaloberry/pine grass (C44) closed forest (.05), Engelmann spruce-subalpine fir/green alder (C25) closed forest (.01), and lodgepole pine/twinflower-fireweed (S5) burns (.01).

PILEATED WOODPECKER *Dryocopus pileatus* PIWO

STATUS AND DISTRIBUTION

The Pileated Woodpecker breeds in forested regions of Canada from northern B.C. and the southern Mackenzie District across southcentral Canada to Nova Scotia. It withdraws from the northernmost areas of its range during winter (Godfrey 1966).

The Pileated Woodpecker is an uncommon permanent resident of KNP. Five sightings of this species were reported from the Sinclair watershed, Kootenay valley and Vermilion valley in June 1943 (Munro and Cowan 1944). Most sightings are from the Redstreak area through the Sinclair Creek watershed and Kootenay valley, although it occurs throughout the park.

As many as four Pileated Woodpeckers were heard drumming on spring migration surveys. They were heard along Sinclair Cr. from Kimpton Cr. to Olive Lake, at Kootenay Viewpoint, McLeod Meadows, Crook's Meadow and along the Kootenay River. A total of 23 was recorded on 605 circular bird plots.

There is one nesting record for this species; in June 1973 a pair nested in a dead spruce on an avalanche slope along the Floe Lake trail (LRH).

HABITAT

The Pileated Woodpecker occurs in mature mixed and coniferous forest containing dead timber. They are predominant in pine forest with aspen stands, spruce-fir forest, and Douglas fir forest. The Pileated Woodpecker is most common in the Montane and Lower Subalpine Ecoregions occurring most often on Ecosites AT4(.03), DR6(.02), FR1(.01), and WY2(.01).

The most important vegetation types are: lodgepole pine/buffaloberry/showy aster (C6) closed forest (.07), lodgepole pine/green alder/feathermoss (C10) closed forest (.07), Douglas fir/hairy wild rye (C1) closed forest (.01), and spruce-aspen-lodgepole pine (paper birch)/buffaloberry/pine grass (C44) closed forest (.01).

OLIVE-SIDED FLYCATCHER *Contopus borealis* OLFL

STATUS AND DISTRIBUTION

The Olive-sided Flycatcher occurs in wooded regions throughout Canada except for the far northern and prairie regions (Godfrey 1966).

The Olive-sided Flycatcher was seen in "various places" throughout the Vermilion valley by Munro and Cowan (1944) on 13 June 1943.

The Olive-sided Flycatcher is a common and widespread summer resident in KNP. It arrives in early to mid-May and leaves before the end of August. There are no nest records but it undoubtedly breeds in KNP. A total of 75 was recorded on 605 circular bird plots.

HABITAT

This species is found in a great variety of habitats from the Montane Ecoregion to timberline. Olive-sided Flycatchers inhabit burns, mixed forests, coniferous forests and Upper Subalpine krummholz vegetation.

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=.03), followed by the Lower Subalpine Ecoregion (DI=.01). Ecosites on which the highest densities of this species occur are: AT4 (.23), FR1 (.12), and DR6 (.07).

The most important vegetation types are: lodgepole pine/buffaloberry/showy aster (C6) closed forest (.32), spruce/Labrador tea/brown moss (O11) open forest (.13), and white spruce/buffaloberry/feathermoss (C37) closed forest (.07).

WESTERN WOOD-PEWEE *Contopus sordidulus* WEPE

STATUS AND DISTRIBUTION

The Western Wood-Pewee occurs throughout B.C. and western Canada (Godfrey 1966).

Cowan and Munro saw this species "on several occasions" during June 1943 and took one specimen.

The Western Wood-Pewee is a common but local summer resident in KNP. It occurs most commonly in the Kootenay valley, arriving around mid-May and remaining until late August. There are no nest records although two recently-fledged young were sighted along Dog Lake trail on 9 June 1974 (naturalist files). A total of 19 was recorded on 605 circular bird plots.

HABITAT

This species usually occurs in mixed forest in the Montane Ecoregion, especially where aspen predominates (Van Tighem 1977).

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=.01), followed by the Lower Subalpine Ecoregion (DI=only two observations). Ecosites on which the highest densities of this species occur are: VL2 (.21), AT4 (.14), and CV1 (.03).

The most important vegetation types are: lodgepole pine/buffaloberry/showy aster (C6) (.32), dwarf birch-shrubby cinquefoil-willow/brown moss (S1) (.09), and spruce/Labrador tea/brown moss (O11) (.03).

ALDER FLYCATCHER *Empidonax alnorum* ALFL

STATUS AND DISTRIBUTION

The Alder Flycatcher occurs across northern Canada south to south-central B.C. and the boreal forest of eastern Canada (Salt and Salt 1976).

The historical data are very confusing for the Alder Flycatcher and the very similar Willow Flycatcher (see Willow Flycatcher species account for further information).

The Alder Flycatcher is a rare and local summer resident, having been recorded only five times. All records are of singing males during the breeding season, which indicates that this species may nest in the park.

HABITAT

This species usually prefers shrubby wetlands and the brushy parts of fens (Van Tighem 1977). All records are from the Montane Ecoregion in ridged terrain with streams or seepage areas between the ridges (DR8) or floodplain wetlands (VL2). All records have been from dwarf birch-shrubby cinquefoil-willow/brown moss (S1) meadows.

WILLOW FLYCATCHER *Empidonax traillii* WIFL

STATUS AND DISTRIBUTION

The Willow Flycatcher occurs in southern Canada from B.C. to the Great Lakes region of Ontario (Salt and Salt 1976).

This species and the Alder Flycatcher were previously considered to be one species: Traill's Flycatcher. Munro and Cowan (1944) called the Traill's Flycatcher the "least common flycatcher in the park".

The Willow Flycatcher is an uncommon and local summer resident in wetland areas of the Kootenay valley. All records for the park are of singing males in June and July. The species arrives in late May and leaves in late August (Holroyd and Van Tighem 1983) . There are no nest records but the observations of singing males in suitable habitat indicate that the Willow Flycatcher likely breeds here. A total of two was recorded on 605 circular bird plots.

HABITAT

This species prefers shrubby wetland areas (S1) on Montane alluvial Ecosites (VL2, DR8). The Willow Flycatcher is the common "Traill's Flycatcher" of the Columbia valley outside the park (Van Tighem 1977).

LEAST FLYCATCHER *Empidonax minimus* LEFL

STATUS AND DISTRIBUTION

The Least Flycatcher occurs in northern and eastern B.C. and throughout most of southern Canada (Godfrey 1966).

The Least Flycatcher is a rare and local summer resident, having been recorded six times. There are no nest records, but since all sightings are of singing males during the breeding season, it probably nests in the park. Least Flycatchers are common in the Columbia valley outside the park boundary (Van Tighem 1977).

HABITAT

The Least Flycatcher occurs in deciduous habitats. In the park all sightings have been from deciduous or mixed wood habitats (C44, S1) within the Montane Ecoregion.

HAMMOND'S FLYCATCHER *Empidonax hammondii* HAFL

STATUS AND DISTRIBUTION

Hammond's Flycatcher occurs throughout B.C. except for the northeastern corner and throughout the mountainous regions of southwestern Alberta (Godfrey 1966).

Hammond's Flycatcher was first observed in KNP in June 1943 by Munro and Cowan (1944). Due to the difficulty of identification the historical status of Hammond's Flycatcher and the very similar Dusky Flycatcher is somewhat obscure.

The Hammond's Flycatcher is a common and widespread summer resident in KNP. It arrives around mid-May and has usually departed, along with the other ***Empidonax*** flycatchers, by the end of August. Autumn observations of species within this group are unreliable at best. Although it undoubtedly breeds commonly, only one nest has been found. On 28 June 1981 a nest containing young was discovered along Stoddart Cr. (RMW). Fledged young were observed in Sinclair Canyon on 18 July 1983 (RMW). A total of 135 was recorded on 605 circular bird plots. and a density of 0.25 males/ha was recorded on the Dolly Varden Creek breeding bird grid (FR3;C44) in 1983 (see section 3.3 above).

HABITAT

This species inhabits coniferous and mixed forests from the Montane to the Lower Subalpine Ecoregion.

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=.14), followed by the Lower Subalpine Ecoregion (DI=.02). Ecosites on which the highest densities of this species occur are: VL6 (.35), DR7 (.32), DR8 (.26), and DR6 (.18).

The most important vegetation types are: aspen/hairy wild rye-peavine (C16) closed forest (.64), spruce/Labrador tea/brown moss (O11) open forest (.24), lodgepole pine/buffaloberry/pine grass (C38) closed forest (.24) and white spruce/buffaloberry/feathermoss (C37) closed forest (.23).

DUSKY FLYCATCHER *Empidonax oberholseri* **DUFL**

STATUS AND DISTRIBUTION

The Dusky Flycatcher occurs throughout B.C. except for the northeastern corner. Its Canadian range also includes southern Yukon, southwestern Alberta and the Cypress Hills of Alberta and Saskatchewan (Godfrey 1966).

Munro and Cowan (1944) considered the Dusky Flycatcher to be "less common than Hammond's Flycatcher" in 1943. Due to the difficulty of identification the historical status of Dusky Flycatcher and the very similar Hammond's Flycatcher is somewhat obscure.

The Dusky Flycatcher is an uncommon and local summer resident in KNP. It arrives near the beginning of May and leaves with the rest of the flycatchers before the end of August.

A nest was discovered in a Douglas fir tree at Stoddart Cr. in June 1982 (GLH). There are no other breeding records but it is presumed to breed in suitable locations along Stoddart Cr. and on the lower slopes of Mt. Wardle. A density of 0.25 males/ha was found on the Stoddart Creek breeding bird grid in 1983 (see section 3.3 above). A total of 47 was recorded on 605 circular bird plots.

HABITAT

This species usually occurs in dry low scrubby growth or mixed forests within the Montane Ecoregion.

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=.04), followed by the Ecoregion (DI=). Ecosites on which the highest densities of this species occur are: WY2 (.22), DG3 (.13), and WY1 (.10).

The most important vegetation types are: Douglas fir-ponderosa pine/wheatgrass (O24) open forest (.25), aspen/hairy wild rye-showy aster (C22) closed forest (.24) and Douglas fir/hairy wild rye (C1) closed forest (.16).

WESTERN FLYCATCHER *Empidonax difficilis* **WEFL**

STATUS AND DISTRIBUTION

The Western Flycatcher occurs in western and southern B.C. and southwestern Alberta (Godfrey 1966). There are no historical records for the park.

The Western Flycatcher is a rare summer resident in the park. A singing male was observed near the Daer fire road on 22 June 1983 (RMW). This species may be more common than our data indicate due to the fact that its habitat is difficult to sample.

HABITAT

This species usually occurs in moist, shady areas of coniferous or mixed forests, especially in ravines and along streams (Godfrey 1966). The KNP record is from a mixed, mainly coniferous forest (C44) along a moist stream valley in the Montane Ecoregion.

WESTERN KINGBIRD *Tyrannus verticalis*

WEKI

STATUS AND DISTRIBUTION

The Western Kingbird occurs in southeastern B.C. through to southern Manitoba and rarely, southern Ontario (Godfrey 1966).

There are only three records of this species from KNP, all from the middle 1970's. Individuals were seen twice in the Kootenay valley in June and once at the Aquacourt in July.

The Western Kingbird is a rare summer visitor to KNP. It is possible that this species may nest within the park occasionally, since it breeds at Radium Hot Springs.

HABITAT

All observations of this species have been from the Montane Ecoregion. Outside the park, the Western Kingbird frequents open habitats in dry areas.

EASTERN KINGBIRD *Tyrannus tyrannus*

EAKI

STATUS AND DISTRIBUTION

The Eastern Kingbird occurs throughout B.C. except for the northwest region and across most of southern Canada (Godfrey 1966). The Eastern Kingbird is common in the Columbia valley wetlands outside the park.

The Eastern Kingbird is an uncommon and local summer resident of KNP. It was first observed on 18 August 1965 (naturalist files). It is often seen along the lower Kootenay River, Dolly Varden Cr. and Settler's Road beaver ponds and less commonly elsewhere (Van Tighem 1977). The earliest spring record is from Sinclair Canyon on 20 May 1974 (naturalist files) and the latest on 30 August 1980 (LRH). Although Eastern Kingbirds undoubtedly nest in the park there is only one probable breeding record; that of six individuals feeding together (family group) north of Settler's Road (naturalist files).

HABITAT

This species occurs primarily in the Montane Ecoregion. It prefers open floodplain areas (DR8) dominated by shrubby wetlands and dead trees which it uses for perching and nesting.

HORNED LARK *Eremophila alpestris*

HOLA

STATUS AND DISTRIBUTION

The Horned Lark occurs throughout Canada in suitable nesting locations. It is absent or very local in forested regions (Godfrey 1966).

The Horned Lark is a rare migrant in KNP. There is only one observation for the park; a single bird was seen along Highway 93 in the lower Kootenay valley on 27 March 1982 (DMP).

HABITAT

The Horned Lark usually nests in open prairies, alpine tundra, along sea coasts, or in cultivated fields (Godfrey 1966). In BNP and JNP it breeds in dry Alpine meadows of the Front Ranges (Holroyd and Van Tighem 1983) . On migration this species is often seen in open areas, particularly roadsides.

TREE SWALLOW *Tachycineta bicolor* TRSW

STATUS AND DISTRIBUTION

The Tree Swallow occurs throughout Canada except for the far northern regions (Godfrey 1966). Munro and Cowan (1944) reported "several pairs" of this species nesting in the Kootenay Crossing burn.

The Tree Swallow is an uncommon summer resident in KNP. It arrives around mid-May and is present until about mid-August. The highest count is from Dog Lake on 5 June 1983 when five were recorded (RMW). It is usually encountered in small flocks of two or three birds. The species breeds from the upper Vermilion valley to the lower Kootenay valley. A total of one was recorded on 605 circular bird plots.

HABITAT

The Tree Swallow usually occurs in wetland areas with suitable nesting sites (VL2, DR8, HC1). Flooded areas with numerous standing dead trees (O11) are the species preferred habitat (Godfrey 1966). They may also utilize disturbed sites like nesting boxes and telephone poles (Van Tighem 1977). Almost all records come from within the Montane Ecoregion but the species has occasionally been observed in the Lower Subalpine Ecoregion.

VIOLET-GREEN SWALLOW *Tachycineta thalassina* VISW

STATUS AND DISTRIBUTION

The Violet-green Swallow occurs throughout B.C. except the northeastern corner. It is also found in the Yukon and in southwestern Alberta (Godfrey 1966).

Munro and Cowan (1944) reported the species "in small numbers" in the Kootenay Crossing burn.

The Violet-green Swallow is a common summer resident occurring in highest numbers in the Sinclair Cr. drainage where up to eight have been observed (naturalist files). The highest count is ten at Dog Lake on 16 May 1983 (RMW). Violet-green Swallows are usually observed in small flocks of up to five birds. The species is an early migrant with the first records in early April. It has generally departed by mid-August. It nests commonly in the southern part of the park. A total of one was recorded on 605 circular bird plots.

HABITAT

Violet-green Swallows are found in both natural and disturbed sites, nesting in cavities on cliff faces, in dead trees, cavities in buildings, and bird boxes. It is most common around inhabited areas of the Sinclair Canyon but ranges throughout the Montane Ecoregion, foraging over wetlands and open areas.

NORTHERN ROUGH-WINGED SWALLOW *Stelgidopteryx serripennis* ROSW

STATUS AND DISTRIBUTION

The Northern Rough-winged Swallow occurs in southern and central B.C. and across southern Canada as far as southwestern Quebec (Godfrey 1966).

Munro and Cowan (1944) reported six pairs nesting at Kootenay Crossing and "more from Kootenay Crossing to Sinclair Summit."

The Northern Rough-winged Swallow is a common summer resident of KNP from Vermilion Crossing south (Van Tighem 1977). It arrives in late May and leaves near the end of August. Flocks of 25 to 50 have been seen at Kootenay Pond (RMW; Seel 1965) and flocks of 15 at Dog Lake on two occasions (RMW). Northern Rough-winged Swallows are most often seen in small groups of five or six birds. The species has nested at Kootenay Crossing, along the Kootenay River near the Conservation Corps camp, and in other scattered locations in the banks of the Kootenay River (RMW). A total of two was recorded on 605 circular bird plots.

HABITAT

The Northern Rough-winged Swallow forages over lakes and rivers of the Montane Ecoregion. This species usually excavates its own burrows in river banks of sand, clay, or gravel (Godfrey 1966).

BANK SWALLOW *Riparia riparia* BKSW

STATUS AND DISTRIBUTION

The Bank Swallow occurs throughout B.C. except for the southwestern coastal region. It is also found across southern Canada to Newfoundland (Godfrey 1966). The first park record is from Kootenay Pond on 7 August 1965 (Seel 1965).

The Bank Swallow is an uncommon and local summer resident from the lower Vermilion valley to the lower Kootenay valley. It arrives about mid-May and is usually gone by the first of September. A colony of about 50 birds has nested in the road cut beneath Mt. Wardle for several years. It also nests in small colonies of five to ten pairs in scattered localities along the Kootenay River near Settler's Road (RMW). The maximum count is 50 from Mt. Wardle on 30 May 1981 (KVT, RMW) and Kootenay Pond on 4 June 1983 (RMW) but they are usually found in small flocks of five or six birds.

HABITAT

This species forages over water bodies in the Montane Ecoregion. The Bank Swallow excavates its own burrows in steep banks of sand, sandstone, clay, and gravel, usually close to water (Godfrey 1966).

CLIFF SWALLOW *Hirundo pyrrhonota* CLSW

STATUS AND DISTRIBUTION

The Cliff Swallow occurs throughout B.C. and Canada, south of the treeline (Godfrey 1966).

Munro and Cowan (1944) reported a pair nesting on "a hard sand cliff" near Kootenay Crossing.

The Cliff Swallow is a common but local summer resident of KNP. There are two main colonies of Cliff Swallows in KNP. The largest, which consists of over 200 nests, is under the Kootenay Crossing bridge and the other, with fewer than 50 nests, under the Vermilion Crossing bridge. Elsewhere it is most often encountered in small flocks of three or four birds. The species can be found throughout the Kootenay and Vermilion River valleys, where as a late migrant, it arrives in late May or early June. It departs in early September. A total of 10 was recorded on 605 circular bird plots.

HABITAT

All records of this species come from the Montane Ecoregion. Most Cliff Swallow nests are on bridges but there are a few natural cliff nests along the Kootenay River (RMW). The species is often found foraging for insects over water bodies or other open areas.

MANAGEMENT CONSIDERATIONS

On 8 June 1982 over 200 Cliff Swallow nests were destroyed by road maintenance crews on the Kootenay Crossing bridge (MMP). By 29 July they had renested and 242 nests were counted (LRH). However, such disruption severely stresses the birds, reducing nest success.

BARN SWALLOW *Hirundo rustica* BNSW

STATUS AND DISTRIBUTION

The Barn Swallow occurs throughout B.C. and southern Canada. It is also present in the southern Yukon and Northwest Territories (Godfrey 1966).

Munro and Cowan (1944) did not report this species for the park.

The Barn Swallow is common and widespread in KNP. It breeds commonly at low elevations throughout the park. This summer resident arrives in early April and often remains well into September. The maximum count is 30 on 30 May 1982 (MMP); it is often seen in flocks of up to ten individuals. A total of nine was recorded on 605 circular bird plots.

HABITAT

The Barn Swallow often forages for insects over water and other open areas close to suitable nesting habitat. The species has become well adapted to man and nests on most man-made structures within the Montane, and less commonly, Lower Subalpine Ecoregions. It also nests occasionally in natural situations such as overhanging cliffs along rivers (RMW).

GRAY JAY *Perisoreus canadensis* GRJA

STATUS AND DISTRIBUTION

The Gray Jay occurs throughout Canada south of treeline excluding the southern plains (Godfrey 1966).

Munro and Cowan (1944) reported "small bands" from Dolly Varden Cr. to Marble Canyon and collected both young and adults.

The Gray Jay is a common and widespread permanent member of the KNP avifauna occurring in all watersheds. The only nest was found at Kootenay Crossing on 23 April 1982 (W.Taylor pers. comm.) but fledged young have been seen on many occasions. It is usually encountered in small flocks or family groups. A total of 80 was recorded on 605 circular bird plots.

HABITAT

This species usually occurs in coniferous and mixed forests, forest openings, and bogs (Godfrey 1966) from valley bottom to timberline.

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=.09), followed by the Lower Subalpine Ecoregion (DI=.09). Ecosites on which the highest densities of this species occur are: HD3 (.54), DR7 (.32), BY4 (.31), and PL1 (.28).

The most important vegetation types are: lodgepole pine/buffaloberry/pine grass (C38) closed forest (.19), Engelmann spruce-subalpine fir/false azalea (C14) closed forest (.17), Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) closed forest (.16), and Engelmann spruce-subalpine fir/heather (O10) open forest (.16).

STELLER'S JAY *Cyanocitta stelleri* STJA

STATUS AND DISTRIBUTION

Steller's Jay occurs throughout western and southern B.C. and in the mountains of southwestern Alberta (Godfrey 1966).

Munro and Cowan (1944) reported individual Steller's Jays from Kootenay Crossing and Sinclair Summit during the winter of 1942/43.

The Steller's Jay is an uncommon permanent resident of KNP. There are two breeding records: a family group was seen along the Floe Lake trail on 21 August 1976 (KVT) and a dead fledgling was found along the Numa Cr. trail on 24 June 1983 (RMW). This species seems to move to the valley bottoms during winter and to higher elevations in spring (Van Tighem 1977). The Steller's Jay is seen in small flocks of up to four birds. A total of three was recorded on 605 circular bird plots.

HABITAT

In KNP Steller's Jay usually occurs in coniferous and mixed forests, often near open areas such as avalanche slopes. During the winter, they are often found near human settlements. All records are from the Montane and Lower Subalpine Ecoregions.

CLARK'S NUTCRACKER *Nucifraga columbiana* CLNU

STATUS AND DISTRIBUTION

Clark's Nutcracker occurs throughout southern B.C. and southwestern Alberta (Godfrey 1966).

Munro and Cowan (1944) reported fledged young from Vermilion Crossing and Crook's meadow on 18 June 1943. They also saw the species at Mt. Wardle and Marble Canyon during the winter of 1942/43.

Clark's Nutcracker is a common permanent resident of KNP. It is usually found at high elevations during the summer, and valley bottoms during the winter (Van Tighem 1977). There are numerous records of fledged young but no nests have been located. They are usually observed in small groups but large flocks of up to 50 birds have been reported during the winter near Redstreak campground (Seel 1965b; LRH). A total of 79 was recorded on 605 circular bird plots.

HABITAT

Clark's Nutcracker usually occurs in coniferous forests at high altitudes, especially in burns and other open areas.

The highest density, based on circular bird census plot samples, is in the Alpine, at timberline Ecoregion (DI=.06), followed by the Upper Subalpine Ecoregion (DI=.05). Ecosites on which the highest densities of this species occur are: PL6 (.32), WF3 (.21), EG2 (.19), and WH1 (.14).

The most important vegetation types are: Engelmann spruce-subalpine fir/heather (O10) open forest (.32), Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4) open forest (.16), and Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) closed forest (.02).

BLACK-BILLED MAGPIE *Pica pica* BLMA

STATUS AND DISTRIBUTION

The Black-billed Magpie occurs throughout B.C. (uncommon along southwestern coastline) and east to Manitoba and western Ontario (Godfrey 1966).

Munro and Cowan (1944) cite warden reports of Black-billed Magpies "occurring more regularly" in the Kootenay valley before a predator program took place.

The Black-billed Magpie is a rare, non-breeding visitor to the park. It is most common as a post-breeding wanderer during the fall (15 records) and winter (six records), especially along Highway 93 feeding on roadkills. There are four records from the spring, all in the Redstreak area, and no summer records. A magpie was seen at Kootenay Crossing during autumn migration in 1982 (MMP). The Black-billed Magpie is common in the Columbia valley outside the park.

HABITAT

The Black-billed Magpie prefers "thickets and scattered trees in open places rather than heavy forest" (Godfrey 1966). The main habitats utilized by Black-billed Magpies in KNP are roadsides and Douglas fir open forest (05). All records have been from the Montane Ecoregion.

AMERICAN CROW *Corvus brachyrynchos* COCR

STATUS AND DISTRIBUTION

The American Crow occurs throughout B.C. except for the west coast and also across southern Canada (Godfrey 1966).

Munro and Cowan (1944) called the American Crow "casual" at Kootenay Crossing. They thought that American Crows, attracted by abundant carrion, may invade the park during bighorn sheep die-offs.

The American Crow is a rare visitor to KNP. It commonly nests in the Columbia valley but has not been found nesting in the park. All but three records are from the summer. In January 1982 up to seven individuals were observed in several locations in the southern part of the park (LRH). A total of seven was recorded on 605 circular bird plots.

HABITAT

The American Crow utilizes a wide variety of habitats but "prefers open places for foraging and wooded areas for nesting, resting and roosting" (Godfrey 1966). It is most likely to be encountered in open forests of the Montane Ecoregion in the southern part of KNP (O24, 05, C1, C5).

COMMON RAVEN *Corvus corax* CORA

STATUS AND DISTRIBUTION

The Common Raven occurs throughout Canada except for the southern prairies (Godfrey 1966).

Munro and Cowan (1944) observed "several" Common Ravens at Kootenay Crossing and in the lower Kootenay valley during the winter of 1942/43.

The Common Raven is a common permanent resident, encountered singly or in small flocks, throughout the park. They have nested near McLeod Meadows in 1970 (naturalist files), along the Cross River fire road in 1981 (RMW), and often on the walls of Sinclair Canyon (park wildlife cards). A total of 53 was recorded on 605 circular bird plots.

HABITAT

This species occurs in many habitats but prefers forest edges and roadways. Most KNP nests are from rock faces but two have been found in trees.

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=.02), followed by the Lower Subalpine Ecoregion (DI=.01). Ecosites on which the highest densities of this species occur are: WY1 (.13), AT1 (.04), VL6 (.03), and WY2 (.02).

The most important vegetation types are: Douglas fir/hairy wild rye (C1) closed forest (.07), lodgepole pine/buffaloberry/pine grass (C38) closed forest (.04), and lodgepole pine/false azalea/grouseberry (C20) closed forest (.03).

BLACK-CAPPED CHICKADEE ***Parus atricapillus*** **BLCH**

STATUS AND DISTRIBUTION

The Black-capped Chickadee occurs throughout B.C. except the southwestern coastal region (Godfrey 1966).

Munro and Cowan (1944) reported one pair of Black-capped Chickadees from the Tokumm Cr. area on 25 June 1943.

The Black-capped Chickadee is a common permanent resident at low elevations throughout the park. It is usually found in small flocks of up to six birds. A maximum count of 15 was obtained on a roadside survey through the Kootenay valley on 11 May 1982 (MMP) and a flock of ten, including five fledglings, was observed near Cobb Lake on 10 July 1981 (RMW). One nest was found at Nipika in June 1975 (KVT). Another nest was found in a snag along the south boundary cut in June 1982 (MMP). The Black-capped Chickadee often occurs in mixed chickadee flocks in the valley bottoms during the winter. A total of 71 was recorded on 605 circular bird plots.

HABITAT

The Black-capped Chickadee usually occurs in wet and dry deciduous and mixed forests, especially where there is abundant deciduous understory.

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=.23), followed by the Lower Subalpine Ecoregion (DI=.01). Ecosites on which the highest densities of this species occur are: AT4 (.64), DR6 (.60), DR8 (.33), and DR3 (.31).

The most important vegetation types are: white spruce-western larch-Douglas fir/bunchberry (C45) closed forest (1.57), lodgepole pine/buffaloberry/showy aster (C6) closed forest (.90), lodgepole pine/green alder/feathermoss (C10) closed forest (.78), and spruce-aspen-lodgepole pine (paper birch)/buffaloberry/pine grass (C44) closed forest (.33).

MOUNTAIN CHICKADEE *Parus gambeli* MOCH

STATUS AND DISTRIBUTION

The Mountain Chickadee is found in the mountainous regions of northwestern, central, and southern B.C. and southwestern Alberta (Godfrey 1966).

Munro and Cowan (1944) reported the Mountain Chickadee from Crook's Meadow.

The Mountain Chickadee is a common permanent resident, found in all watersheds. It is usually found in pairs or small flocks during the summer but at other seasons flocks of ten birds are not uncommon. It is especially common in the Redstreak area during the winter, where it mixes with other chickadee species. The maximum count was 50 in Goodsir Pass on 29 December 1982 (MMP). There are four breeding records: a pair was found nesting in a Douglas fir stump in Sinclair Canyon on 16 May 1983 (RMW), a nest with young was found in a dead spruce in Ottertail Pass on 29 June 1983 (RMW), a family group was observed on the Stanley Glacier trail on 3 August 1976 (KVT), and fledged young were seen in spruce/fir forest along Tokumm Cr. on 7 July 1983 (RMW). This is the most common chickadee species in the park. A total of 112 was recorded on 605 circular bird plots.

HABITAT

The Mountain Chickadee occurs in coniferous and mixedwoods, especially open types, from valley bottom to timberline.

The highest density, based on circular bird census plot samples, is in the Upper Subalpine Ecoregion (DI=.20), followed by the Montane Ecoregion (DI=.10). Ecosites on which the highest densities of this species occur are: BP2 (.74), EG2 (.59), EG3 (.40), and PL1 (.37).

The most important vegetation types are: Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4) open forest (.74), Douglas fir/hairy wild rye (C1) closed forest (.55), subalpine larch-subalpine fir/grouseberry-everlasting (C23) closed forest (.39), and spruce/Labrador tea/brown moss (O11) open forest (.25).

BOREAL CHICKADEE *Parus hudsonicus* BOCH

STATUS AND DISTRIBUTION

The Boreal Chickadee occurs across Canada south of treeline, excluding the southwest B.C. coast and the southern prairies (Godfrey 1966).

Munro and Cowan (1944) reported "pairs nesting in thick spruce woods" in June 1943.

The Boreal Chickadee is a common permanent resident of KNP. In the summer this species is usually encountered in small flocks of two or three individuals. At other seasons it is found in larger flocks of up to ten birds, often in association with other chickadee species. The maximum count was a flock of ten on 19 January 1983 in the lower Kootenay valley (LRH). Munro and Cowan (1944) provide the only breeding evidence although the species undoubtedly nests in the park. A total of 45 was recorded on 605 circular bird plots.

HABITAT

The Boreal Chickadee usually occurs in mixed and coniferous forests from valley bottom to timberline, being most common in the Lower Subalpine Ecoregion.

The highest density, based on circular bird census plot samples, is in the Lower Subalpine Ecoregion (DI=.14), followed by the Montane Ecoregion (DI=.05). Ecosites on which the highest densities of this species occur are: SB3 (.52), BY4 (.40), HD3 (.35), CV1 (.31), and FV6 (.30).

The most important vegetation types are: spruce/Labrador tea/brown moss (O11) open forest (.35), Engelmann spruce-subalpine fir/false azalea (C14) closed forest (.26), white spruce-Douglas fir/feathermoss (C5) closed forest (.23), and Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) closed forest (.13).

RED-BREASTED NUTHATCH *Sitta canadensis* RENU

STATUS AND DISTRIBUTION

The Red-breasted Nuthatch occurs in coniferous forests throughout B.C. and across most of southern Canada (Godfrey 1966).

Munro and Cowan (1944) reported that the Red-breasted Nuthatch "occurs in all forest types" within KNP.

The Red-breasted Nuthatch is a common permanent resident, occurring in all watersheds. It is usually seen singly or in small groups of up to three. The maximum count is ten from McLeod Meadows in late June 1976 (Trottier *et al.* 1976). Nests have been found near Nixon Lake in a dead aspen on 10 July 1983 (RMW) and in a dead spruce at the administration building parking lot on 26 May 1983 (MMP). A total of 124 was recorded on 605 circular bird plots.

HABITAT

This species usually occurs in coniferous and mixed forests although on migration it can be found in deciduous woods.

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=.05), followed by the Lower Subalpine Ecoregion (DI=.01). Ecosites on which the highest densities of this species occur are: WY2 (.11), DR6 (.11), and FR3 (.08).

The most important vegetation types are: white spruce-western larch-Douglas fir/bunchberry (C45) closed forest (.24), aspen/hairy wild rye-peavine (C16) closed forest (.16), and Douglas fir/hairy wild rye (C1) closed forest (.11).

WHITE-BREASTED NUTHATCH *Sitta carolinensis* WHNU

STATUS AND DISTRIBUTION

The White-breasted Nuthatch has a patchy distribution throughout southern Canada. It is a permanent resident in many of the river valleys in southern interior B.C. (Godfrey 1966).

The White-breasted Nuthatch is a rare visitor to KNP. There are only four records, all from the Redstreak area in the Sinclair drainage. Seel (1965) saw single birds near Redstreak campground on 7 February 1964, 24 May 1965, and 2 August 1965. An individual was seen at Redstreak campground on 13 August 1973(naturalist files). These records probably represent occasional wanderings of the species from the Columbia valley.

HABITAT

The White-breasted Nuthatch prefers mature deciduous forests over most of its range but breeds in Ponderosa Pine forests in southern B.C. (Godfrey 1966). All records in KNP are from the Douglas fir open forest (O5) within the Montane Ecoregion. The species also breeds in the riverine forests of the Columbia valley, outside the park boundary (Van Tighem 1977).

BROWN CREEPER *Certhia americana*

BRCR

STATUS AND DISTRIBUTION

The Brown Creeper occurs in western and southern B.C. and across Canada in most wooded areas (Godfrey 1966).

This species was first reported for the park along the Kindersley Pass trail on 21 June 1964 (Seel 1965). The Brown Creeper is an uncommon permanent resident of KNP. It is usually observed singly but is also seen in small flocks of up to three individuals. There is one nesting record from early June 1981; a pair was seen feeding young in a nest in mixed forest near Crook's Meadow (GLH). A total of 16 was recorded on 605 circular bird plots.

HABITAT

The Brown Creeper usually occurs in mature coniferous forests although it can be found in deciduous habitats during migration and winter.

The highest density, based on circular bird census plot samples, is in the Lower Subalpine Ecoregion (DI=.07), followed by the Montane Ecoregion (DI=.01). Ecosites on which the highest densities of this species occur are: AL3 (.26), SB3 (.26), CV1 (.21), HD3 (.17), and BY5 (.16).

The most important vegetation types are: Engelmann spruce-subalpine fir/rock willow/bracted lousewort (O14) open forest (.41), western red cedar/oval leaf blueberry (C42) closed forest (.17), Engelmann spruce-subalpine fir/false azalea (C14) closed forest (.08), and Engelmann spruce-subalpine fir/green alder (C25) closed forest (.07).

ROCK WREN *Salpinctes obsoletus*

ROWR

STATUS AND DISTRIBUTION

The Rock Wren occurs in southeastern B.C., southern Alberta, and southern Saskatchewan (Godfrey 1966).

The Rock Wren is a rare and very local summer resident. It is only found on the bluffs above Stoddart Cr. There are no early and late dates available but there are records of singing males throughout June. There were at least two males on territory on 29 June 1981 and no more than three on 4 June 1982 (KVT). No nests have been found but they undoubtedly breed in this area.

HABITAT

The Rock Wren usually occurs on rocky outcrops along dry southern exposures. It probably nests in cracks and crevices in rock outcrops. It is found within the Montane Ecoregion in KNP. Highest densities, based on circular bird census plots, are on the following ecosites: DG3(.03) and WY2(.02).

The most important vegetation type is: Douglas fir-ponderosa pine/wheatgrass (O24) open forest with rocky bluffs (.06).

WINTER WREN *Troglodytes troglodytes*

WIWR

STATUS AND DISTRIBUTION

The Winter Wren is found throughout B.C. except for some of the drier southern areas. It also occurs in most coniferous forest regions throughout Canada (Godfrey 1966).

Munro and Cowan (1944) saw this species along Tokumm Cr., at Vermilion Crossing, and in the "cedar grove" below Redstreak campground.

The Winter Wren is a common summer resident throughout the park. It usually arrives in early April and often remains until near the end of October. It is usually seen singly or in pairs but family groups are present late in the summer. There are three breeding records: a pair feeding seven young in a nest was found near Marble Canyon campground on 22 July 1965 (Seel 1965), a nest with young was found in Ottertail Pass on 28 June 1983 (RMW), and two birds giving frequent alarm calls were seen near Daer fire tower on 22 June 1983 (RMW). A total of 136 was recorded on 605 circular bird plots.

HABITAT

The Winter Wren is commonest in mature coniferous forests along streams and bogs, especially those having lush undergrowth and deadfall. It can be found from valley bottom to timberline.

The highest density, based on circular bird census plot samples, is in the Lower Subalpine Ecoregion (DI=.18), followed by the Upper Subalpine Ecoregion (DI=.08). Ecosites on which the highest densities of this species occur are: FV3 (.66), SB6 (.49), BY5 (.46), and PL1 (.33).

The most important vegetation types are: western red cedar/oval leaf blueberry (C42) closed forest (.38), Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) closed forest (.30), Engelmann spruce-subalpine fir/heather (O10) open forest (.26), Engelmann spruce-subalpine fir/rock willow/bracted lousewort (O14) open forest (.26), and Engelmann spruce-subalpine fir/false azalea (C14) closed forest (.21).

AMERICAN DIPPER *Cinclus mexicanus* DIPP

STATUS AND DISTRIBUTION

The American Dipper occurs along mountain streams throughout B.C. and southwestern Alberta (Godfrey 1966).

Munro and Cowan (1944) reported American Dippers from Tokumm Cr., Marble Canyon, Vermilion Crossing, and Sinclair Cr. during the summer of 1943. They recorded one in juvenile plumage near the Hot Springs.

The American Dipper is a common permanent resident, occurring along almost every water-course in the park. American Dippers have nested in the canyon near Iron Gates tunnel for many years. They have also nested at Marble Canyon, Helmet Cr., and below Stanley Glacier. This species is usually encountered singly, in pairs, or in family groups.

HABITAT

This species usually occurs along swift-flowing streams and rivers that remain open in the winter. It is also uncommonly seen around lakes and ponds (Godfrey 1966). It nests on rocky ledges or crossbeams of bridges over and beside streams.

GOLDEN-CROWNED KINGLET *Regulus satrapa* GOKI

STATUS AND DISTRIBUTION

The Golden-crowned Kinglet occurs throughout B.C. and southern Canada in coniferous woodland (Godfrey 1966).

Munro and Cowan (1944) found "several pairs" of Golden-crowned Kinglets in spruce woods along Tokumm Cr. and reported then from Vermilion Crossing and Kootenay Crossing.

The Golden-crowned Kinglet is a common permanent member of the KNP avifauna. It is more commonly seeen in the summer. It is usually observed in small flocks of two to five individuals but larger flocks are not uncommon. The maximum count is 15 from near Dog Lake on 16 May 1983 (RMW). There are two breeding records: a fledgling along the Vermilion River near the burn on 23 August 1973 (Scott 1973) and five fledglings with adults near Dog Lake on 8 July 1983 (RMW). A total of 291 was recorded on 605 circular bird plots.

HABITAT

This species occurs in mature coniferous forests from valley bottom to timberline, being most common in spruce/fir forests.

The highest density, based on circular bird census plot samples, is in the Lower Subalpine Ecoregion (DI=.76), followed by the Montane Ecoregion (DI=.39). Ecosites on which the highest densities of this species occur are: CA2 (1.46), BY5 (1.32), AL3 (1.32), BY4 (1.17), and FV6 (.90).

The most important vegetation types are: lodgepole pine/green alder/feathermoss (C10) closed forest (1.59), Douglas fir/hairy wild rye (C1) closed forest (1.43), western red cedar/oval leaf blueberry (C42) closed forest (1.28), white spruce-subalpine fir/bunchberry-horsetail (C41) closed forest (.96), Engelmann spruce-subalpine fir/false azalea (C14) closed forest (.93), and Engelmann spruce-subalpine fir/green alder (C25) closed forest (.83).

RUBY-CROWNED KINGLET *Regulus calendula* RUKI

STATUS AND DISTRIBUTION

The Ruby-crowned Kinglet occurs throughout the forested regions of Canada (Godfrey 1966).

It is a common summer resident, occurring in all watersheds of KNP. It is usually encountered singly or in small flocks of two or three in the summer but flocks of up to six and seven are commonly observed during migration. The maximum count is 20 from the mixed woods near Dog Lake on 16 May 1983 (RMW). The earliest park arrival was 19 April 1983 in the Kootenay valley (MMP). The latest was from the Redstreak area on 7 September 1965 (Seel 1965). The only breeding evidence is three fledged young seen with adults at Daer Pond on 8 July 1981 (RMW). A total of 172 was recorded on 605 circular bird plots.

HABITAT

The Ruby-crowned Kinglet occurs most commonly in open forests, especially near timberline. It is also common in mixed woodland in valley bottoms and in over-mature spruce forests along streams and lakes (Van Tighem 1977).

The highest density, based on circular bird census plot samples, is in the Upper Subalpine Ecoregion (DI=.07), followed by the Montane Ecoregion (DI=.05). Ecosites on which the highest densities of this species occur are: SB6 (.40), WF3 (.32), BY6 (.32), SB2 (.27), and PL1 (.16).

The most important vegetation types are: Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4) open forest (.53), white spruce-western larch-Douglas fir/bunchberry (C45) closed forest (.24), white spruce-subalpine fir/bunchberry-horsetail (C41) closed forest (.19), Engelmann spruce-subalpine fir/rock willow/bracted lousewort (O14) closed forest (.19), and Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) closed forest (.11).

MOUNTAIN BLUEBIRD *Sialia currucoides* MOBL

STATUS AND DISTRIBUTION

The Mountain Bluebird occurs from Yukon through mainland B.C. and across south-central Canada to Manitoba (Godfrey 1966).

Munro and Cowan (1944) reported several pairs nesting in the "big burn" three miles south of Vermilion Crossing and one pair nesting in a bird house at Crook's Meadow on 17 June 1943.

The Mountain Bluebird is an uncommon summer resident of KNP. The earliest arrival date is 20 March 1965 at Stoddart Cr. (Seel 1965) and the latest is three family groups which remained in the Redstreak area until 6 September 1965 (Seel 1965). The maximum count is 30 at Wolverine Pass on 29 September 1983 (H.Fuhrer). Mountain Bluebirds are usually encountered singly or in pairs.

There are several nesting records from June and July from Redstreak, Crook's Meadow, Mt. Wardle and the Vermilion burn area (Van Tighem 1977). A total of three was recorded on 605 circular bird plots.

HABITAT

The Mountain Bluebird prefers "open habitats such as the Vermilion Pass burn (S5), river flats, and Douglas fir open forest (O5)" (Van Tighem 1977). It is most common in the valley bottoms of the Montane and Lower Subalpine Ecoregions but it has occurred rarely at timberline.

TOWNSEND'S SOLITAIRE *Myadestes townsendi* TOSO

STATUS AND DISTRIBUTION

Townsend's Solitaire occurs in the Yukon, B.C. and southwestern Alberta (Godfrey 1966).

Munro and Cowan (1944) reported seeing this species "regularly along the highway between Sinclair Canyon and Vermilion Crossing".

The Townsend's Solitaire is a common resident throughout the park during the summer and an uncommon species of the valley bottoms, especially near Redstreak, in the winter. Spring migration is early with the first birds arriving in early April. Autumn movements of Townsend's Solitaires usually occur in late August and September. It is usually seen singly or in small flocks of two or three while moving from Alpine breeding territories to wintering areas in the Columbia valley.

There are 11 nest records: seven along the Daer fire road, two in the Vermilion burn, and two from the Redstreak area. The earliest is a nest with three eggs found along the Sinclair Cr. trail on 15 May 1975 (KVT). The earliest fledged young were seen on 22 June 1983 along the Daer fire road (RMW). A total of 79 was recorded on 605 circular bird plots.

HABITAT

The Townsend's Solitaire prefers open forests, timberline areas, and forest edges with sloping terrain (Holroyd and Van Tighem 1983) . In the winter, though, they are common in Douglas fir open forest (O5, O24) in the Montane Ecoregion. During the breeding season this species is often seen giving its flight song in the Alpine Ecoregion although it occurs down to the Montane Ecoregion usually in dry, open areas with rocky bluffs.

The Townsend's Solitaire nests on the ground, usually under an overhanging cliff, cutbank or roadcut.

The highest density, based on circular bird census plot samples, is in the Alpine Ecoregion (DI=.06), followed by the Subalpine Ecoregion (DI=.03). Ecosites on which the highest densities of this species occur are: DR4 (1.67), BY3 (.86), RD2 (.60), SB1 (.50), and WH8 (.50).

The most important vegetation types are: aspen/hairy wild rye-showy aster (C22) closed forest (.32), lodgepole pine/twinflower-fireweed (S5) burns (.16), subalpine larch-subalpine fir/heather (O13) open forest (.08), and lodgepole pine/buffaloberry/pine grass (C38) closed forest (.08).

VEERY *Catharus fuscescens* VEER

STATUS AND DISTRIBUTION

There are two unverified records of this species from the Vermilion burn, upstream from Marble Canyon campground: Scott (1973) reported one on 13 June 1973 and O'Keefe (1975) reported one during July 1975, both from the same vicinity.

These observations in subalpine coniferous burn vegetation are atypical of habitats normally frequented by the Veery. The species is common in lowland deciduous woodland and shrubbery in the Columbia valley but, due to lack of preferred habitat, would not be expected to occur within the park boundaries.

There are only two recent records for BNP and none from JNP (Holroyd and Van Tighem 1983) .

SWAINSON'S THRUSH *Catharus ustulatus* SWTH

STATUS AND DISTRIBUTION

The Swainson's Thrush occurs throughout the forested regions of Canada south of treeline (Godfrey 1966).

Swainson's Thrush is a common summer resident of the lower elevations in KNP. The earliest migrant is from Nipika on 30 May 1975 (KVT). They leave before the end of August. The species is rarely encountered in groups.

Munro and Cowan (1944) reported "nesting activity" near Vermilion Crossing and one immature was sighted along the Dog Lake trail on 24 August 1973 (naturalist files). The species undoubtedly nests commonly in the park. A total of 506 was recorded on 605 circular bird plots.

HABITAT

The Swainson's Thrush almost exclusively inhabits closed forests within the Montane and Lower Subalpine Ecoregion. It inhabits coniferous and mixed woodlands, especially those with deciduous understories.

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=.15), followed by the Lower Subalpine Ecoregion (DI=.13). Ecosites on which the highest densities of this species occur are: FR3 (.40), DR2 (.28), CA2 (.28), DR4 (.27), and BY1 (.21).

The most important vegetation types are: white spruce-subalpine fir/bunchberry-horsetail (C41) closed forest (.51), Engelmann spruce-subalpine fir/green alder (C25) closed forest (.22), white spruce/buffaloberry/feathermoss (C37) closed forest (.22), spruce-aspen-lodgepole pine (paper birch)/buffaloberry/pine grass (C44) closed forest (.21), and lodgepole pine/green alder/feathermoss (C10) closed forest (.20).

HERMIT THRUSH ***Catharus guttatus*** **HETH**

STATUS AND DISTRIBUTION

The Hermit Thrush occurs throughout Canada in forested regions (Godfrey 1966).

Munro and Cowan (1944) reported the Hermit Thrush from Tokumm Cr. in "several places at higher elevations".

The Hermit Thrush is a common summer resident in coniferous forests throughout KNP. The earliest spring record is from below Mt. Whymper on 16 May 1973 (Scott 1973) but the main migration occurs in late May and early June. They are usually gone before the end of August. Hermit Thrushes are usually seen singly or in pairs.

The only breeding record is of fledged young seen in Upper Subalpine forest at Goodsir Pass on 19 July 1983 (MMP). The species undoubtedly nests commonly in the park. A total of 311 was recorded on 605 circular bird plots.

HABITAT

The Hermit Thrush occurs in subalpine coniferous forests, especially in more open areas such as burns and timberline regions.

The highest density, based on circular bird census plot samples, is in the Upper Subalpine Ecoregion (DI=.18), followed by the Lower Subalpine Ecoregion (DI=.04). Ecosites on which the highest densities of this species occur are: LV3 (.52), PL1 (.48), EG1 (.42), SB6 (.40), and EG4 (.32).

The most important vegetation types are: Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) closed forest (.39), subalpine larch-subalpine fir/grouseberry-everlasting (C23) closed forest (.19), subalpine larch-subalpine fir/heather (O13) open forest (.08), Engelmann spruce-subalpine fir/false azalea (C14) closed forest (.07), and lodgepole pine/twinflower-fireweed (S5) burns (.07).

AMERICAN ROBIN ***Turdus migratorius*** **ROBI**

STATUS AND DISTRIBUTION

The American Robin occurs throughout Canada south of treeline (Godfrey 1966).

The American Robin is a common summer resident, occurring in all watersheds.

Munro and Cowan (1944) called the American Robin "one of the commonest birds in the park from Sinclair Canyon to Vermilion Pass". During the breeding season they are usually encountered singly or in pairs but on migration they can be seen in flocks of ten or more. Spring migration starts in early March and peaks in late April and early May. The maximum count is 72 on a Kootenay valley survey on 27 April 1982 (MMP). Robins stay well into the autumn with the latest record being at the Wardens' headquarters in Sinclair Canyon on 10 December 1981 (DMP). They occasionally winter in the Columbia valley.

The American Robin has been found nesting from the upper Vermilion valley to the lower Sinclair Canyon. The earliest nest is from the Dog Lake trail on 27 May 1974 (naturalist files). A total of 310 was recorded on 605 circular bird plots.

HABITAT

The American Robin is found "in open forests and edge habitats throughout the park, being most common at timberline, along the river flats, and in the Douglas fir savannah"(O5) (Van Tighem 1977).

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=.29), followed by the Upper Subalpine Ecoregion (DI=.12). Ecosites on which the highest densities of this species occur are: VL6 (.78), JN1 (.65), DR8 (.53), WY1 (.52), and DR6 (.40).

The most important vegetation types are: white spruce-subalpine fir/bunchberry-horsetail (C41) closed forest (1.04), lodgepole pine/buffaloberry/twinflower (C19) closed forest (.65), aspen/hairy wild rye-peavine (C16) closed forest (.65), dwarf birch-shrubby cinquefoil-willow/brown moss (S1) shrubland (.47), and spruce-aspen-lodgepole pine (paper birch)/buffaloberry/pine grass (C44) closed forest (.44).

VARIED THRUSH *Ixoreus naevius* VATH

STATUS AND DISTRIBUTION

The Varied Thrush occurs throughout the Yukon, B.C. and mountainous southwestern Alberta (Godfrey 1966).

Munro and Cowan (1944) found the Varied Thrush "in pairs or single birds" from Sinclair Summit to Tokumm Cr. They discovered a pair with young in a nest "up Tokumm Cr." on 25 June 1943.

The Varied Thrush is a common summer resident throughout the park, arriving in late March and reaching peak numbers in late April. The latest record is from the Redstreak area on 3 November 1980 (LRH). They are usually observed singly or in pairs. The maximum count is 65 on a Kootenay valley migration survey 27 April 1982 (MMP).

There are three breeding records: a fledgling was observed on the fire road near Dolly Varden Cr. on 5 July 1983 (RMW), a female was observed carrying food near the Rockwall Pass trail on 25 July 1982 (MMP), and the Munro and Cowan (1944) record cited above. A total of 442 was recorded on 605 circular bird plots.

HABITAT

This species prefers dense, moist stands of subalpine coniferous forest. It is also common in open timberline and mixed forests (Van Tighem 1977).

The highest density, based on circular bird census plot samples, is in the Upper Subalpine Ecoregion (DI=.23), followed by the Lower Subalpine Ecoregion (DI=.14). Ecosites on which the highest densities of this species occur are: LV3 (.52), PL1 (.46), SX2 (.42), CV1 (.41), and EG3 (.41).

The most important vegetation types are: Engelmann spruce-subalpine fir/valerian-fleabane (O9) open forest (1.06), Engelmann spruce-subalpine fir/rock willow/bracted lousewort (O14) open forest (.64), Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) closed forest (.50), western red cedar/oval leaf blueberry (C42) closed forest (.29), and subalpine larch-subalpine fir/grouseberry-everlasting (C23) closed forest (.24).

WATER PIPIT *Anthus spinoletta* WAPI

STATUS AND DISTRIBUTION

The Water Pipit breeds in suitable habitat in B.C., southwestern Alberta, and throughout the arctic (Godfrey 1966). On migration it occurs throughout southern Canada.

The first park record is a road kill from the Vermilion valley on 15 May 1965 (Seel 1965).

The Water Pipit is a common summer resident of KNP, first appearing in small flocks along Highway 93 during April and May. The earliest record is from the lower Kootenay valley on 23 April 1982 (MMP, LRH). The latest autumn record is three from the Kootenay River flats on 28 October 1982 (MMP). The maximum count is of a flock of more than 100 from the Kootenay River flats on 13 September 1982 (DMP).

There are three nesting records, all from the alpine: a female on nest with four eggs in Kindersley Pass on 9 July 1982 (MMP), a female on nest with four eggs in Numa Pass on 13 July 1982 (MMP), and a nest containing four nestlings above Goodsir Pass on 25 July 1982 (DMP). A total of 93 was recorded on 605 circular bird plots.

HABITAT

The Water Pipit is usually found in the Alpine Ecoregion, where it inhabits meadows and rocky areas. On migration it is found in non-vegetated areas such as roadsides, gravel pits, lakeshores, and moist grasslands(Godfrey 1966).

The highest density, based on circular bird census plot samples, is in the Alpine Ecoregion (DI=1.80), followed by the Upper Subalpine Ecoregion (DI=.33). Ecosites on which the highest densities of this species occur are: JN1 (2.79), SX1 (1.68), RD2 (1.37), and BS2 (.86).

The most important vegetation types are: heather-everlasting (L5) heath tundra (2.23), mountain avens-snow willow-moss campion (H1) tundra (1.03), and subalpine larch-subalpine fir/heather (O13) open forest(.36).

BOHEMIAN WAXWING *Bombycilla garrulus* BOWA

STATUS AND DISTRIBUTION

The Bohemian Waxwing breeds throughout Yukon and B.C. and the northern prairie provinces (Godfrey 1966). It winters throughout the southern portions of the western provinces.

Munro and Cowan (1944) found a pair of Bohemian Waxwings breeding near Kootenay Crossing on 19 June 1943. They also observed a pair near Vermilion Crossing.

The Bohemian Waxwing is an uncommon permanent resident. "It has been observed sporadically at locations throughout the park in summer" (Van Tighem 1977). During the winter it is usually encountered, often in large flocks, in the Kootenay and Sinclair valleys. The maximum count is 300 from the wardens' headquarters in Sinclair Canyon on 29 November 1982 (DMP).

There is a record of an adult with one fledgling from the Paint Pots on 23 July 1976 (naturalist files). The only other nesting record is from Munro and Cowan (1944) at Kootenay Crossing.

HABITAT

During the breeding season Bohemian Waxwings usually inhabit coniferous or mixed woodlands, muskegs, and burns (Godfrey 1966). Summer Bohemian Waxwing records in KNP come from the Montane and Lower Subalpine Ecoregions, especially along the Vermilion River floodplains. All winter records from KNP have come from the Montane Ecoregion, usually from around inhabitations where fruit and berry-producing trees and shrubs are plentiful.

CEDAR WAXWING *Bombycilla cedrorum* CEWA

STATUS AND DISTRIBUTION

The Cedar Waxwing occurs throughout southern Canada (Godfrey 1966).

The first park record is from near Redstreak campground on 4 July 1964 (Seel 1965).

The Cedar Waxwing is an uncommon summer resident of lowland areas from the lower Vermilion valley to Sinclair Canyon. All the records are from May to August. The earliest record is ten from the Kootenay River floodplains near the Conservation Corps camp on 6 May 1982 (DMP) and the latest is three from Sinclair Canyon on 30 August 1983 (RMW).

The Cedar Waxwing is most often observed in forests along the Kootenay River. It probably breeds locally around wetland areas in the park. This species is a common member of the riparian woodland avifauna in the Columbia valley outside the park. A total of 17 was recorded on 605 circular bird plots.

HABITAT

The Cedar Waxwing usually prefers open woodland or woodland edges around ponds or other water bodies, especially in those areas with a lot of dead trees for perching. They may occur in deciduous or coniferous habitats.

All records are from the Montane Ecoregion. DR7 (.51), VL6 (.30), and WY2 (.05).

The most important vegetation types are: white spruce-subalpine fir/bunchberry-horsetail (C41) closed forest (.68), lodgepole pine/buffaloberry/pine grass (C38) closed forest (.22), and Douglas fir-ponderosa pine/wheatgrass (O24) open forest (.09).

NORTHERN SHRIKE *Lanius excubitor* NOSH

STATUS AND DISTRIBUTION

The Northern Shrike breeds from Yukon across northern Canada to Labrador. In Winter and on migration it occurs in open areas across southern Canada (Godfrey 1966).

The Northern Shrike is a rare migrant, having occurred but once in KNP. In the airport clearing near Kootenay Crossing a single Northern Shrike was observed on 31 March 1978 (LRH). This species may rarely occur in the park during migration and winter (October through early April). It is usually observed in small numbers in the Columbia valley during the winter.

LOGGERHEAD SHRIKE *Lanius ludovicianus* LOSH

STATUS AND DISTRIBUTION

The Loggerhead Shrike occurs across most of southern Canada. In B.C. it is a rare visitor to southern areas (Godfrey 1966).

There is one unverified record for KNP. Two Loggerhead Shrikes were reported from Sinclair Canyon near the park gates on 20 May 1974 (naturalist files).

The Loggerhead Shrike inhabits open country in lowland areas (Godfrey 1966). KNP does not contain ideal habitat for this species and it would not normally be expected to occur here.

EUROPEAN STARLING *Sturnus vulgaris* STAR

STATUS AND DISTRIBUTION

The European Starling was introduced to New York from Europe in 1890. It has expanded its range rapidly and now breeds throughout southern Canada (Godfrey 1966). The first park record was eight seen at McLeod Meadows on 10 April 1965 (Seel 1965).

The European Starling is an uncommon and local summer resident of KNP. It is more common on migration along the roadsides and river flats of the lower Kootenay valley. The earliest record is one from McLeod Meadows on 13 March 1981 (LRH). The latest autumn record and maximum count of 35 comes from the roadside in the lower Kootenay valley on 28 October 1982 (MMP).

There are four nesting records, all from the lower Kootenay valley: one from Dolly Varden picnic site, two from Kootenay Crossing and one near McLeod Meadows. The earliest record is two fledgings with an adult near Dolly Varden picnic site on 17 May 1974 (naturalist files).

HABITAT

The European Starling inhabits open areas around inhabitations within the park. They usually use woodpecker holes and natural cavities in trees and buildings (Godfrey 1966).

MANAGEMENT CONSIDERATIONS

This introduced species has become a pest across most of North America. Not only does it cause extensive crop damage but it also usurps our native species nesting sites. It is instrumental in the drastic range reductions of some eastern bird species (Godfrey 1966).

SOLITARY VIREO *Vireo solitarius* SOVI

STATUS AND DISTRIBUTION

The Solitary Vireo occurs throughout southern and central B.C. and across southern Canada excluding the plains region (Godfrey 1966).

Munro and Cowan (1944) reported a singing male from John McKay Cr. on 27 June 1943.

The Solitary Vireo is a common summer resident of KNP. The earliest spring record is from the Redstreak area on 30 April 1981 (GRS). Peak migration occurs in late May and early June. The latest autumn observation is one in Sinclair Canyon on 30 August 1983 (RMW) The maximum count is ten from a Kootenay valley migration survey on 3 June 1982 (MMP). Solitary Vireos have only been seen singly or in pairs.

There is a single nest record: a pair was observed feeding two young in a nest in Sinclair Canyon on 22 July 1965 (Seel 1965). A total of 91 was recorded on 605 circular bird plots.

HABITAT

The Solitary Vireo prefers open mixed coniferous and deciduous woods (Godfrey 1966). In KNP it is most often found in the Douglas fir open forest and riparian mixed woodland within the Montane Ecoregion (Van Tighem 1977).

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=.09), followed by the Ecoregion (DI=). Ecosites on which the highest densities of this species occur are: WY1(.32), WY2(.22), DR7(.19), AT4(.14), and VL6(.11).

The most important vegetation types are: Douglas fir/hairy wild rye (C1) closed forest (.29), lodgepole pine/buffaloberry/bunchberry (C39) closed forest (.24), white spruce/buffaloberry/feathermoss (C37) closed forest (.14), Douglas fir-ponderosa pine/wheatgrass (O24) open forest (.11), and lodgepole pine/buffaloberry/pine grass (C38) closed forest (.09).

WARBLING VIREO *Vireo gilvus* WAVI

STATUS AND DISTRIBUTION

The Warbling Vireo breeds across Canada from southwestern Mackenzie to southern Ontario (Godfrey 1966). It occurs throughout B.C.

Munro and Cowan (1944) reported this species from Vermilion Crossing on 10 June 1943 and "several" from Dolly Varden Cr. and one from John McKay Cr. on 14 June 1943.

The Warbling Vireo is a common summer resident, usually arriving around mid to late May. The earliest record is from the mixed forest along the Cross River fire road on 16 May 1981 (KVT). Spring migration peaks in late May and early June. The maximum count of 13 singing males was obtained on a Kootenay valley migration survey on 30 May 1982 (MMP). The latest record is from Redstreak on 27 July 1973 (naturalist files) although this species is likely present into August. Warbling Vireos are usually observed singly or in pairs.

Three nests have been found: on 24 June 1981 a male was found singing from a nest near the Daer fire road (RMW), on 29 June 1981 a nest was found near the Cobb Lake parking lot (RMW), and on 30 June 1981 near Sora Pond, adults were observed carrying food to nestlings (RMW). A total of 90 was recorded on 605 circular bird plots.

HABITAT

The Warbling Vireo is almost always found in the Montane Ecoregion but has also been observed in the Lower Subalpine Ecoregion. It is found wherever deciduous shrubbery and woodland occurs, especially along Dolly Varden Cr., on avalanche slopes, alluvial fans, and in mixed woodlands in the Kootenay valley (Van Tighem 1977).

The highest density, based on circular bird census plot samples, is in the Ecoregion (DI=), followed by the Ecoregion (DI=). Ecosites on which the highest densities of this species occur are: ('Montane','.07','Lower Subalpine','.02')> WY1(.19), VL6(.18), DR4(.16), DR2(.13), and DR6(.11).

The most important vegetation types are: white spruce-subalpine fir/bunchberry-horsetail (C41) closed forest (.51), aspen/hairy wild rye-showy aster (C22) closed forest (.40), Douglas fir/hairy wild rye (C1) closed forest (.15), and spruce/Labrador tea/brown moss (O11) open forest (.14).

RED-EYED VIREO *Vireo olivaceus* REVI

STATUS AND DISTRIBUTION

The Red-eyed Vireo occurs in suitable habitat throughout southern Canada. In B.C. it is only absent from the northwest corner (Godfrey 1966).

Munro and Cowan (1944) reported three singing males "in dense deciduous growth" along McKay Cr. on 27 June 1943.

The Red-eyed Vireo is a rare and local summer resident of KNP. It has been seen along the Cross River fire road (KVT, RMW), at McKay Cr. (KVT), in Sinclair Canyon (KVT), and along the Kootenay

River near Kootenay Crossing (MMP). The records are all from May and June, the earliest being 16 May 1981 along the Cross River fire road (KVT, RMW). All records are of singing males. Although no nests have been found, it may nest rarely in KNP.

"The species is common in poplar woodland adjacent to the park" (Van Tighem 1977) and may occasionally wander to the deciduous forest along Sinclair Cr.

HABITAT

The Red-eyed Vireo occurs primarily in deciduous trees and tall shrubbery, especially along streams and lakes (Godfrey 1966). In KNP this species has been observed on aspen-dominated alluvial fans (FR3, C16) and in mixed forest (C44) along stream courses (HD3, DR5, VL6).

TENNESSEE WARBLER *Vermivora peregrina* TEWA

STATUS AND DISTRIBUTION

The Tennessee Warbler breeds across most of forested Canada except for the southern prairies(Godfrey 1966).

Munro and Cowan (1944) reported that Tennessee Warblers were "common in spruce woods" during June 1943.

The Tennessee Warbler is an uncommon summer resident, most often observed in the Vermilion valley (Van Tighem 1977). The earliest spring record is of a singing male from the Vermilion Crossing area on 31 May 1983 (MMP). The maximum count is eight singing males from the Paint Pots to Ochre Cr. along the Vermilion River (KVT). "Autumn migration occurs in August and early September" (Holroyd and Van Tighem 1983) .

There is no breeding evidence but the species probably nests locally in suitable locations in the Vermilion valley. A total of 13 was recorded on 605 circular bird plots.

HABITAT

In KNP The Tennessee Warbler prefers spruce dominated wetland forests, usually within the Lower Subalpine Ecoregion.

The highest density, based on circular bird census plot samples, is in the Lower Subalpine Ecoregion (DI=.01), followed by the Montane Ecoregion (DI=.01). Ecosites on which the highest densities of this species occur are: FR3(.06), VL6(.05), FV6(.04), and BY4(.04).

The most important vegetation types are: white spruce/buffaloberry/feathermoss (C37) closed forest (.11), dwarf birch-shrubby cinquefoil-willow/brown moss (S1) shrubland (.09), and spruce/Labrador tea/brown moss (O11) open forest (.07).

ORANGE-CROWNED WARBLER *Vermivora celata* ORWA

STATUS AND DISTRIBUTION

The Orange-crowned Warbler occurs across Canada south of treeline, excluding the prairies (Godfrey 1966)

Munro and Cowan (1944) did not report this species from KNP. The first park record was observed in some deciduous growth in the Vermilion burn below Mt. Whymper on 5 June 1973 (Scott 1973).

The Orange-crowned Warbler is a common summer resident of KNP. The earliest spring record is from a lower Kootenay valley migration survey on 11 May 1982 (MMP). The maximum count is 20 from the deciduous shrubbery surrounding Sundew Pond on 19 May 1983 (RMW). "Autumn migration is from mid-August to late September, peaking in late August" (Holroyd and Van Tighem 1983) .

There are no nest records although the species likely breeds in the extensive mixed forests of the Kootenay valley as well as in other suitable locations. A total of 72 was recorded on 605 circular bird plots.

HABITAT

The Orange-crowned Warbler occurs in areas with deciduous vegetation throughout the park. It prefers wet shrublands, avalanche slopes, and extensive deciduous/coniferous mixed forest.

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=.07), followed by the Lower Subalpine Ecoregion (DI=.02). Ecosites on which the highest densities of this species occur are: DR4(.37), DR2(.17), DG6(.11), VL6(.10), and WY1(.10).

The most important vegetation types are: green alder/fern (S13) shrubland (.24), aspen/hairy wild rye-showy aster (C22) closed forest (.24), lodgepole pine/green alder/feathermoss (C10) closed forest (.20), white spruce-subalpine fir/bunchberry-horsetail (C41) closed forest (.19), and Douglas fir/hairy wild rye (C1) closed forest (.11).

YELLOW WARBLER *Dendroica petechia* YEWA

STATUS AND DISTRIBUTION

The Yellow Warbler occurs in suitable habitat throughout forested Canada (Godfrey 1966).

Munro and Cowan (1944) did not report this species from the park. The first record is of a singing male carrying nesting material along the southwestern tributary of Numa Cr. on 2 June 1970 (naturalist files).

The Yellow Warbler is an uncommon and local summer resident. They have been observed in shubbery along Dolly Varden Cr., the Kootenay River, Numa Cr., at Dog Lake, Sundew Pond, and at the base of Mt. Wardle. All records are of singing males. The earliest spring record is of two from the marsh south of Dog Lake on 26 May 1981 (RMW). "Autumn migration occurs from August to mid-September" (Holroyd and Van Tighem 1983) .

The only breeding evidence is the above record of a male carrying nesting material. The species probably breeds locally in the shrubbery along the Kootenay River.

Yellow Warblers are very common in the riparian forests of the Columbia valley outside the park. A total of two was recorded on 605 circular bird plots.

HABITAT

The Yellow Warbler prefers wet willow and birch shrublands (S1, S8) within the Montane Ecoregion.

MAGNOLIA WARBLER *Dendroica magnolia* MAWA

STATUS AND DISTRIBUTION

The Magnolia Warbler occurs in northeastern, central, and north-central B.C. and across most of forested southern Canada to Newfoundland (Godfrey 1966).

The Magnolia Warbler is a rare summer resident of KNP. There are four records from the upper Vermilion valley, within the Lower Subalpine Ecoregion, none of which are well documented. Seel (1965) reports a singing male from Marble Canyon on 3 June 1965 and another male from the same vicinity on 6 September 1965. The other two records are from the Vermilion burn: one singing male on 10 July 1973 (GRS) and one male from along the Vermilion River, upstream from Marble Canyon, on 16 July 1973 (Scott 1973).

In BNP and JNP the Magnolia Warbler is a rare migrant and rare summer resident (Holroyd and Van Tighem 1983) . Wade (1977) calls it a "very rare migrant" in Yoho National Park.

HABITAT

The Magnolia Warbler usually prefers "young or low coniferous woods or open mixedwood and edges "(Godfrey 1966) of the Montane and Lower Subalpine Ecoregions (Holroyd and Van Tighem 1983) .

CAPE MAY WARBLER *Dendroica tigrina* CMWA

STATUS AND DISTRIBUTION

In Canada the Cape May Warbler breeds east of the Rockies, from Alberta to Nova Scotia (Godfrey 1966). It has occurred three times in BNP and twice in JNP (Holroyd and Van Tighem 1983) . In B.C., it has been found in the Peace River parklands (Godfrey 1966).

There is only one record of the species for KNP. A singing male was observed along the Cross River fire road on 16 June 1981 (KVT, RMW). During the same spring at least two Cape May Warblers were recorded near Banff (Holroyd and Van Tighem 1983) .

This species is accidental in KNP and would not be expected to occur again.

HABITAT

The Cape May Warbler prefers "coniferous woods and mixed woods, especially more open types and edges" (Godfrey 1966). In KNP the record is from an aspen-dominated, mixed deciduous/coniferous forest, situated on an alluvial fan (FR3, C16).

YELLOW-RUMPED WARBLER *Dendroica coronata* YRWA

STATUS AND DISTRIBUTION

The Yellow-rumped Warbler occurs in forested regions thoughout Canada (Godfrey 1966). The subspecies, *D.c. memorabilis* "Audubon's Warbler" and *D.c. coronata* "Myrtle Warbler", both occur in the park.

Munro and Cowan (1944) reported that "Audubon's Warbler" was the "commonest warbler in the park" and that "males were singing in various types of wooded habitat" in June 1943.

The Yellow-rumped Warbler is a common and widespread summer resident of KNP. It occurs in every watershed, arriving in the area in late April and remaining until September. The earliest spring record is of one male at Sundew Pond on 26 April 1978 (LRH). The latest autumn record is a flock of three at the base of Mt. Wardle on 17 September 1982 (DMP). The Yellow-rumped Warbler is most often observed singly or in small flocks of up to five birds, although it is occasionally seen in larger flocks. The maximum count of 45, including 30 "Myrtle Warblers", was recorded at Sundew Pond on 19 May 1983 (RMW). "Myrtle Warblers" were recorded on three occaisions: a male along Kimpton Cr. on 14 June 1976 (KVT); a singing male in the Upper Subalpine forest of Vermilion Peak on 4 June 1983 (RMW); and several were seen in the forest surrounding the Settler's Road beaver ponds on 20 May 1983 (MMP).

One nest has been found; a pair was observed feeding young in a nest along the East Kootenay fire road on 26 June 1981 (KVT). Fledged young have been observed on numerous occaissions. A total of 474 was recorded on 605 circular bird plots.

HABITAT

This species usually occurs in coniferous forests from valley bottoms to timberline, being most common in the Montane Ecoregion.

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=.49), followed by the Subalpine Ecoregion (DI=.32). Ecosites on which the highest densities of this species occur are: DR4(1.38), WF3(1.06), SB2(.85), CV1(.76), and BP2(.73).

The most important vegetation types are: Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4) open forest (1.27), lodgepole pine/buffaloberry/pine grass (C38) closed forest (.93), spruce/Labrador tea/brown moss (O11) open forest (.80), lodgepole pine/green alder/feathermoss (C10) closed forest (.69), and Douglas fir/hairy wild rye (C1) closed forest (.60).

TOWNSEND'S WARBLER *Dendroica townsendi* TOWA

STATUS AND DISTRIBUTION

In Canada, Townsend's Warbler occurs in the Yukon, in B.C. excluding the northeastern corner, and in the mountains of southwestern Alberta (Godfrey 1966).

Munro and Cowan (1944) found "several" at Vermilion Crossing and along Tokumm Cr. in June 1943.

Townsend's Warbler is a common and widespread summer resident of KNP, occurring in every watershed. Spring migration peaks in late May and early June. A maximum count of 41 was recorded on a Kootenay valley migration survey on 1 June 1982 (MMP). "Autumn migration occurs in August" (Holroyd and Van Tighem 1983) . Townsend's Warblers are usually observed singly or in pairs although small flocks of up to five are not uncommon. It is probably the most abundant bird species in the park during summer.

There are only two nesting records: a nest containing five eggs was found near Numa Cr. on 15 June 1983. It was located on a spruce bough ten feet obove the ground (RMW); a pair was giving frequent alarm calls near the junction of the East Kootenay and Daer fire roads on 22 June 1983 (RMW). A total of 609 was recorded on 605 circular bird plots.

HABITAT

Townsend's Warblers prefer closed coniferous forests, especially those dominated by spruce. It occurs from valley bottoms to timberline, being most common in the Lower Subalpine.

The highest density, based on circular bird census plot samples, is in the Lower Subalpine Ecoregion (DI=.37), followed by the Montane Ecoregion (DI=.27). Ecosites on which the highest densities of this species occur are: AL3(.96), SB3(.80), BY4(.58), FV6(.51), and VL6(.45).

The most important vegetation types are: white spruce-western larch-Douglas fir/bunchberry (C45) closed forest (.72), white spruce-subalpine fir/bunchberry-horsetail (C41) closed forest (.70), Engelmann spruce-subalpine fir/green alder (C25) closed forest (.54), white spruce/buffaloberry/feathermoss (C37) closed forest (.48), and spruce/Labrador tea/brown moss (O11) open forest (.46).

BLACKPOLL WARBLER *Dendroica striata* BPWA

STATUS AND DISTRIBUTION

The Blackpoll Warbler occurs across Canada from treeline south to the central parts of the provinces (Godfrey 1966).

The Blackpoll Warbler is a rare and local summer resident of KNP. There are six records of this species, all of singing males from mid-May to mid-June. Two were observed at the beaverponds near Settler's Road on 4 and 6 June 1975 (KVT), and again on 30 May 1981 (RMW, KVT); two were seen at Dog Lake on 16 May 1983 (RMW); one was heard at a small bog near Settler's Road on 8 June 1983 (RMW); two were observed at the upper end of Marble Canyon on 18 June 1976 (KVT, J. Mulchinock); and one was observed at the springs near the base of Mt. Wardle on 4 June 1983 (MMP).

There are no nesting records but due to the presence of singing males in the proper habitat, it is likely a rare breeder in KNP.

The Blackpoll Warbler is a "common summer resident" of BNP and JNP Parks (Holroyd and Van Tighem 1983) . Wade (1977) reports many sightings from Yoho National Park from late May to mid-July.

HABITAT

The Blackpoll Warbler prefers coniferous forests, especially spruce, often in moist areas (Godfrey 1966). It also occurs in "mixed wood edges, logged and burned areas, and alder thickets." .

All records but one are from the lower Kootenay valley. It has been found in forest edges (O11,C11) around boggy areas (FR1, AT1, VL2) within the Montane Ecoregion and on bluffs in pine/spruce forest (BY7, C20) within the Lower Subalpine Ecoregion.

AMERICAN REDSTART *Setophaga ruticilla* AMRE

STATUS AND DISTRIBUTION

The American Redstart occurs throughout eastern and northern B.C. and across southern Canada in forested regions (Godfrey 1966).

Munro and Cowan (1944) recorded a female of this species at Vermilion Crossing on 10 June 1943.

The American Redstart is an uncommon and local summer resident of KNP. The earliest spring record is of a singing male along the Cross River fire road on 16 May 1981 (KVT, RMW) and the latest autumn record is of a female from the same vicinity on 3 September 1982 (MMP). The maximum count is five from the upper Kootenay River along the West Kootenay fire road on 2 June 1983 (RMW). This species is usually encountered singly or in pairs, although good habitat often provides a retreat for three or four individuals.

There are no breeding records although second-year males and adult males have been observed regularly in the specie's preferred nesting habitat. A territorial male displayed aggressive behavior at Sundew Pond on 9 June 1982 (MMP).

HABITAT

The American Redstart "inhabits tall deciduous shrubbery on alluvial wetlands and avalanche slopes, as well as woodlands with a tall shrub understory, particularly near water" (Holroyd and Van Tighem 1983) .

In KNP this species is most often found in shrubbery (S1, S8) adjacent streams and other wetland areas (VL2, DR6), mixed forests (C44) and aspen dominated alluvial fans (FR3; C16). It occurs primarily in the Montane Ecoregion but has also been seen in the Lower Subalpine Ecoregion.

NORTHERN WATERTHRUSH *Seiurus noveboracensis* NOWA

STATUS AND DISTRIBUTION

The Northern Waterthrush occurs in the Yukon, B.C. except for the southwestern corner, and across Canada in forested regions (Godfrey 1966).

The Northern Waterthrush is an uncommon and local summer resident of KNP. "It occurs regularly at the foot of the Simpson slidepaths and in the flooded timber bordering Daer Pond" (Van Tighem 1977). It is also observed occasionally in wetland areas along the West Kootenay fire road, in seepage areas at the base of Mt. Wardle, and around Cobb Lake. All of the records have been from June where it has been observed singly or in pairs.

This species probably breeds in suitable locations in KNP.

HABITAT

The Northern Waterthrush "inhabits forests, often white spruce-dominated, with tall deciduous shrubbery, bordering wetlands, ponds and lakes, or floodplains that are occasionally flooded" (Holroyd and Van Tighem 1983) .

In KNP this species prefers wet Montane forests, especially those dominated by spruce (O11, C41).

MACGILLIVRAY'S WARBLER *Oporornis tolmiei* MCWA

STATUS AND DISTRIBUTION

In Canada, MacGillivray's Warbler occurs throughout B.C., the mountains and foothills of southwestern Alberta, and the Cypress Hills of Alberta and Saskatchewan (Godfrey 1966).

Munro and Cowan (1944) found this species to be "fairly common in the deciduous vegetation of the slides" along Tokumm Cr. on 25 June 1943. They also found an individual at Vermilion Crossing on 12 June 1943.

MacGillivray's Warbler is a common and widespread summer resident of KNP. The earliest spring record is three singing males from the Simpson slidepath on 3 June 1977 (KVT). "Autumn migration occurs from late August to late September, peaking in early September" (Holroyd and Van Tighem 1983) . This species is usually encountered singly or in pairs.

The only breeding evidence is of an alarmed bird "with a nest in a big group of shrubs" at the base of an avalanche slope near Verdant Cabin on 10 July 1983 (RMW). A total of 15 was recorded on 605 circular bird plots.

HABITAT

MacGillivray's Warbler prefers brushy avalanche slopes but can also be found in other brushy habitats, either wet or dry, usually within the Lower Subalpine Ecoregion.

The highest density, based on circular bird census plot samples, is in the Lower Subalpine Ecoregion (DI=.03), followed by the Montane Ecoregion (DI=.01). Ecosites on which the highest densities of this species occur are: SB1(.15), FV5(.20), DG3(.08), and DR2(.06).

The most important vegetation types are: aspen/hairy wild rye-showy aster (C22) closed forest (.29), Douglas fir/juniper/bearberry (O5) open forest (.12), green alder/fern (S13) avalanche shrub (.11), and Engelmann spruce-subalpine fir/green alder (C25) closed forest (.04).

COMMON YELLOWTHROAT *Geothlypis trichas* YELL

STATUS AND DISTRIBUTION

The Common Yellowthroat occurs throughout B.C. and across southern Canada to Newfoundland (Godfrey 1966).

Munro and Cowan (1944) reported two males "in a flooded willow swamp" along Dolly Varden Cr. on 14 June 1943.

The Common Yellowthroat is a common but local summer resident of KNP. It is found around wetland areas in the Kootenay valley. The earliest spring record is of one male from Kootenay Crossing marsh on 15 May 1965 (Seel 1965). The latest autumn record is from Kootenay Pond on 16 September 1982 (LRH). Common Yellowthroats are usually observed singly or in pairs.

There are three breeding records: in a flooded area near Settler's Road a pair was observed "tending a nest" on 13 July 1965 (Seel 1965), a female with five eggs was found along Dolly Varden Cr. on 30 June 1975 (KVT), and a female was observed with two fledged young at Dog Lake on 31 August 1982 (MMP). A total of 17 was recorded on 605 circular bird plots.

HABITAT

The species prefers wet, shrubby habitats at low elevations (Van Tighem 1977). All records are from the Montane Ecoregion of the Kootenay valley.

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=.05). Ecosites on which the highest densities of this species occur are: VL2(.96), DR6(.32), and DR8(.09).

The most important vegetation types are: spruce/Labrador tea/brown moss (O11) open forest (.56), dwarf birch-shrubby cinquefoil-willow/brown moss (S1) shrubland (.41), and spruce-aspen-lodgepole pine (paper birch)/buffaloberry/pine grass (C44) closed forest (.04).

WILSON'S WARBLER *Wilsonia pusilla* WIWA

STATUS AND DISTRIBUTION

Wilson's Warbler occurs throughout most of southern Canada except for the prairie regions (Godfrey 1966).

Munro and Cowan (1944) observed "several" at Kootenay Crossing on 18 and 22 June 1943.

Wilson's Warbler is a common and widespread summer resident of KNP. The earliest spring record is of one male near Kootenay Viewpoint on 19 May 1982 (MMP) and the latest autumn record is one from along the East Kootenay fire road near Daer Pond on 16 September 1982 (DMP). Wilson's Warbler is usually encountered singly or in pairs.

The only breeding evidence is a record by (Seel 1965) of a pair "tending a nest in a willow thicket" at Crook's Meadow on 13 July 1965. A total of 118 was recorded on 605 circular bird plots.

HABITAT

Wilson's Warblers prefer "shrubby avalanche slopes, coniferous or mixed woodland having a dense, shrubby understory, and wetlands bordered by tall shrubs" (Van Tighem 1977). It occurs from valley bottoms to timberline, being most common in the Lower Subalpine.

The highest density, based on circular bird census plot samples, is in the Lower Subalpine Ecoregion (DI=.23), followed by the Montane Ecoregion (DI=.08). Ecosites on which the highest densities of this species occur are: FV5(1.41), FV6(.54), BY1(.47), and DG1(.41).

The most important vegetation types are: green alder/fern (S13) avalanche shrub (.82), Engelmann spruce-subalpine fir/green alder (C25) closed forest (.56), and lodgepole pine/false azalea/grouseberry (C20) closed forest (.46).

WESTERN TANAGER *Piranga ludoviciana* WETA

STATUS AND DISTRIBUTION

In Canada, the Western Tanager occurs throughout B.C., northern and southwestern Alberta, and central Saskatchewan (Godfrey 1966).

Munro and Cowan (1944) reported Western Tanagers from Vermilion Crossing, the Redstreak area, and Crook's Meadow during June 1943.

The Western Tanager is a common summer resident of KNP. The earliest record is from the Sinclair Canyon on 14 May 1982 (park wildlife cards). "Autumn migration occurs in August" (Holroyd and Van Tighem 1983) . It is usually encountered singly or in pairs.

There is a single nesting record. A pair was observed with fledglings near Redstreak campground on 30 July 1965 (Seel 1965). A total of 49 was recorded on 605 circular bird plots.

HABITAT

"The Western Tanager occurs in the Montane and, less frequently, Lower Subalpine Ecoregions. It inhabits Douglas fir forest and other somewhat open, mature coniferous or mixed forests" (Holroyd and Van Tighem 1983) .

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=.05), followed by the Lower Subalpine Ecoregion (DI=.01). Ecosites on which the highest densities of this species occur are: WY1(.22), WY2(.18), DG3(.11), and VL6(.05).

The most important vegetation types are: Douglas fir/hairy wild rye (C1) closed forest (.22), Douglas fir-ponderosa pine/wheatgrass (O24) open forest (.12), and white spruce/buffaloberry/feathermoss (C37) closed forest (.05).

BLACK-HEADED GROSBEAK *Pheucticus melanocephalus* BHGR

STATUS AND DISTRIBUTION

In Canada, the Black-headed Grosbeak occurs throughout southern B.C., and across southern Alberta to southwestern Saskatchewan (Godfrey 1966).

The Black-headed Grosbeak is a rare summer visitor to KNP: there are only three records. A singing male was observed by Lynn and Carson Wade near Marble Canyon on 20 June 1976 (Trottier *et al.* 1977), one was reported from McLeod Meadows on 31 July 1976 (naturalist files), and a pair was observed a half mile south of McLeod Meadows on 18 May 1972 (naturalist files). Inventory staff did not record this species in KNP. Black-headed Grosbeaks are unlikely to occur regularly due to lack of suitable habitat. The species occasionally occurs at Wilmer Wildlife Area in the Columbia valley (Simpson and Kelsall 1978).

HABITAT

The Black-headed Grosbeak usually prefers "more open woodlands (deciduous or mixed), especially where there is an admixture of tall shrubbery along streams, ponds, and lake edges, and woodland openings and margins" (Godfrey 1966).

In KNP, the species has been observed in the Lower Subalpine and Montane Ecoregions. Two records are from mixed forest (C44) and one is from a spruce/fir subalpine forest (C14).

LAZULI BUNTING *Passerina amoena* LZBU

STATUS AND DISTRIBUTION

In Canada, the Lazuli Bunting occurs in south-central B.C., southern Alberta, and southwestern Saskatchewan (Godfrey 1966).

The Lazuli Bunting is a rare summer resident, having been observed only three times in KNP. Two singing males were seen on an avalanche slope north of Ochre Cr. on 1 July 1975 (KVT). A singing bird believed to be of this species, was heard on the same avalanche slope on 20 July 1977 (KVT). A singing male was observed at the Conservation Corps camp during the summer of 1981 (M. Donald, H. Dudynsky pers. com.).

HABITAT

The Lazuli Bunting inhabits "bushy country, burntlands, and clearings" (Godfrey 1966).

In KNP, the Lazuli Bunting has been observed in "small clumps of young aspen" at the base of a lush avalanche slope within the Lower Subalpine Ecoregion and in the mixed forest (C44) of the Montane Ecoregion.

CHIPPING SPARROW *Spizella passerina* CHSP

STATUS AND DISTRIBUTION

The Chipping Sparrow occurs across Canada south of treeline (Godfrey 1966).

Munro and Cowan (1944) reported this species as "common in pairs" throughout open habitats in KNP.

The Chipping Sparrow is a common and widespread summer resident. Spring migration peaks in late May and early June in KNP. The earliest record is of eight individuals at McLeod Meadows on 11 May 1981 (LRH). The maximum count is 61 on a lower Kootenay valley roadside survey on 30 May 1982 (MMP). "Autumn migration occurs in late July and August" (Holroyd and Van Tighem 1983) . The latest record is of one individual from near Redstreak on 25 August 1965 (Seel 1965). Chipping Sparrows are usually observed singly or in pairs but on migration they may be seen in flocks numbering 30 or 40 birds.

There are many nesting records for KNP. The earliest nest was found near the Conservation Corps camp on 30 May 1981 (KVT, RMW). The earliest record of hatched young is a nest with two young and two eggs at Kootenay Crossing on 18 June 1970 (naturalist files). The earliest fledged young was seen on 23 June 1983 at the Sinclair Canyon warden's headquarters (RMW). A total of 357 was recorded on 605 circular bird plots.

HABITAT

The Chipping Sparrow prefers "open woodland and forest edge habitats throughout the park..." (Van Tighem 1977) from valley bottom to timberline.

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=.41), followed by the Upper Subalpine Ecoregion (DI=.31). Ecosites on which the highest densities of this species occur are: WY1(1.17), WY2(1.15), LV2(1.15), AT4(1.08), and SX2(.95).

The most important vegetation types are: lodgepole pine/buffaloberry/showy aster (C6) closed forest (1.83), Douglas fir-ponderosa pine/wheatgrass (O24) open forest (1.22), Engelmann spruce-subalpine fir/willow/ribbed bog moss (O6) open forest (.96), Douglas fir/hairy wild rye (C1) closed forest (.94), spruce/Labrador tea/brown moss (O11) open forest (.84), and subalpine larch-subalpine fir/grouseberry-everlasting (C23) closed forest (.60).

CLAY-COLOURED SPARROW *Spizella pallida* CLSP

STATUS AND DISTRIBUTION

In Canada, the Clay-coloured Sparrow occurs in eastern B.C., Alberta, and across southern Saskatchewan to southern Ontario (Godfrey 1966).

The Clay-coloured Sparrow is a rare visitor to KNP. There are only two records : a singing male was observed at Dog Lake on 27 May 1975 (KVT) and a singing male was observed in a small wetland area near Settler's Road on 17 June 1977 (KVT).

The Clay-coloured Sparrow is a "fairly common resident" and uncommon migrant" in BNP and JNP (Holroyd and Van Tighem 1983) . It is classified as an "occasional summer resident" at Wilmer Wildlife Area in the Columbia valley near the park (Simpson and Kelsall 1978).

HABITAT

The two records are both from dwarf birch (S1) shrublands within the Montane Ecoregion. They are known to breed in this habitat type in the foothills of Alberta (KVT) but these birds were likely just passing through.

BREWER'S SPARROW *Spizella breweri* BRSP

STATUS AND DISTRIBUTION

In Canada, Brewer's Sparrow occurs in southwestern Yukon, southeastern B.C., west-central and southern Alberta, and southwestern Saskatchewan (Godfrey 1966).

Brewer's Sparrow is a rare summer resident, having been recorded only four times: on 17 June 1975, two singing males were seen in the burn below Stanley Glacier (KVT); on 26 June 1983 two singing males were observed on a ridge near Kindersley Pass (MMP); on 29 June 1983 a singing male was recorded on a ridge in the Ottertail River drainage (RMW); on 6 July 1983 a total of five birds, including two singing males, were observed on an avalanche slope near Kaufmann Lake (RMW).

There are no nesting records although they likely nest in small shrubs and krummholtz vegetation within the Upper Subalpine Ecoregion. A total of one was recorded on 605 circular bird plots.

HABITAT

Brewer's Sparrow "inhabits willow and birch-willow shrubbery at timberline as well as subalpine fir krummholtz and the edges of avalanche tracks" (Holroyd and Van Tighem 1983) .

In KNP they have been observed in the Upper Subalpine Ecoregion in open krummholtz (L5) islands, larch/fir (O13) open forest, and shrubby (S2) avalanche slopes.

VESPER SPARROW *Pooecetes gramineus* VESP

STATUS AND DISTRIBUTION

The Vesper Sparrow occurs in southern and eastern B.C., Alberta, and across the rest of southern Canada to Nova Scotia (Godfrey 1966).

Munro and Cowan (1944) reported one from the Radium area on 27 June 1943.

The Vesper Sparrow is an uncommon summer resident of KNP. The earliest spring record and maximum count is a flock of ten seen along the river flats near Settler's road on 12 May 1982 (LRH). The peak spring migration period is in early June. "Autumn migration is in August" (Holroyd and Van Tighem 1983) . The latest autumn record is four from the Hector's Gorge area on 17 September 1982 (DMP).

This species is most often found along the Kootenay River floodplain and in the Stoddart Cr. grasslands.

There is one nesting record. A nest containing four chicks was found in the Mt. Wardle area on 12 June 1979 (LRH). The species probably commonly nests at Stoddart Cr. and along the Kootenay River floodplain. A total of 33 was recorded on 605 circular bird plots.

HABITAT

The Vesper Sparrow prefers open, dry grassland regions within the Montane Ecoregion. On migration they occur throughout the Kootenay valley in open areas and along the river floodplain. ('Montane','.02')> DG3(.13), AT4(.09), and WY2(.08).

The most important vegetation types are: Douglas fir-ponderosa pine/wheatgrass (O24) open forest (.23), yellow dryad-willow herb (H8) meadows (.21), and Douglas fir/hairy wild rye (C1) closed forest (.01).

LARK BUNTING *Calamospiza melanocorys*

STATUS AND DISTRIBUTION

In Canada, the Lark Bunting is found in southern Alberta, Saskatchewan, and western Manitoba. It is "casual" in parts of southern B.C. (Godfrey 1966).

There is only one record for KNP. A migrant male was seen in the company of a flock of juncos on the side of the highway near Dolly Varden Cr. on 26 May 1953 (Banfield 1954).

This is an exceptional record and the Lark Bunting will not likely occur here again.

HABITAT

The Lark Bunting usually occurs on "drier treeless plains and prairies, especially where the grasses have a considerable admixture of sagebrush" (Godfrey 1966).

The KNP record was from disturbed roadside habitat.

SAVANNAH SPARROW *Passerculus sandwichensis* SASP

STATUS AND DISTRIBUTION

The Savannah Sparrow breeds throughout Canada except for the northern islands (Godfrey 1966).

The Savannah Sparrow is an uncommon summer resident of KNP. It is most often observed in the Kootenay valley on migration. Spring migration occurs in late April and May. The earliest spring record and maximum count is five from the Kootenay River flats on 23 April 1982 (DMP). "Autumn migration is from mid-August to early October" (Holroyd and Van Tighem 1983) . It is usually observed singly or in small flocks of up to four individuals.

There is only one nest record: on 2 June 1981 a nest with four eggs was found in a clump of grasses at the edge of Daer Pond (RMW). The species probably nests regularly around wetlands in the Kootenay valley. A total of one was recorded on 605 circular bird plots.

HABITAT

The Savannah Sparrow prefers open areas, especially those with bush, wet grasses, sedges, and shrubbery (S1,- H5, H11). It has only been found in valley bottoms within the Montane and, to a lesser extent, Lower Subalpine Ecoregions. On migration it occurs in open areas, both natural and disturbed.

LE CONTE'S SPARROW *Ammodramus leconteii* LESP

STATUS AND DISTRIBUTION

In Canada, Le Conte's Sparrow occurs east of the Rockies, from Alberta to Quebec. In B.C. it occurs in the Peace River parklands (Godfrey 1966).

There is one record for KNP. A singing male was heard at Dog Lake on 27 May 1975 (KVT). This is a very unusual sighting and will not likely be repeated.

Le Conte's Sparrow is an uncommon summer resident of JNP but has not been recorded in BNP (Holroyd and Van Tighem 1983) .

HABITAT

Le Conte's Sparrow prefers "moist grass and sedge meadows, damp thickly-matted grass and shrub tangles on edges of marshes and bogs, and areas of tall rank grass, either moist or dry" (Godfrey 1966).

In KNP, the only record comes from the willow (S1) shrubland at the north end of Dog Lake.

FOX SPARROW *Passerella iliaca* FOSP

STATUS AND DISTRIBUTION

The Fox Sparrow occurs throughout B.C., the Yukon, western and northern Alberta, and across the northern parts of the provinces to Newfoundland (Godfrey 1966).

Munro and Cowan (1944) reported a singing male from a slidepath south of Vermilion Crossing and two singing males on "slides bordering Tokumm Cr." on 25 June 1943.

The Fox Sparrow is a common and widespread summer resident of KNP. Spring migration is in late April and May (Holroyd and Van Tighem 1983). The earliest record is of one from the Redstreak area on 20 May 1965 (Seel 1965). "Autumn migration is in late August and September" (Holroyd and Van Tighem 1983). Fox Sparrows are usually seen singly or in pairs.

There are no nesting records but the species is undoubtedly a common breeder near timberline throughout the park. A total of 213 was recorded on 605 circular bird plots.

HABITAT

The Fox Sparrow prefers open Upper Subalpine forests and forest edges along avalanche slopes.

The highest density, based on circular bird census plot samples, is in the Upper Subalpine Ecoregion (DI=.20), followed by the Lower Subalpine Ecoregion (DI=.05). Ecosites on which the highest densities of this species occur are: FV5(.53), EG1(.35), EG3(.32), SX2(.29), SB1(.28), and WH1(.28).

The most important vegetation types are: Engelmann spruce-subalpine fir/willow/ribbed bog moss (O6) open forest (.51), green alder/fern (S13) avalanche shrub (.27), subalpine larch-subalpine fir/grouseberry-everlasting (C23) closed forest (.26), Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) closed forest (.22), and Engelmann spruce-subalpine fir/heather (O10) open forest (.22).

SONG SPARROW *Melospiza melodia* SOSP

STATUS AND DISTRIBUTION

The Song Sparrow breeds over most of southern Canada, from coast to coast (Godfrey 1966).

The Song Sparrow is an uncommon migrant and rare summer resident in KNP. Almost all records are from the Kootenay valley wetlands in April and May. There are two summer records, both from the wetlands at Dolly Varden Cr.

This species is an early spring migrant, arriving from late March to late May (Holroyd and Van Tighem 1983). The earliest spring record is of a singing male from the Redstreak area on 5 April 1965 (Seel 1965). "Autumn migration is in August and September" (Holroyd and Van Tighem 1983). The Song Sparrow is "common in shrubbery bordering the colluvial rubble" (Van Tighem 1977).

There are no nesting records but singing males have occasionally been heard along Dolly Varden Cr. in the breeding season. The species may be a rare breeder in these extensive wetlands.

HABITAT

The Song Sparrow prefers "bushy shrubbery along the margins of ponds, lakes, and streams" (Godfrey 1966). It "occurs in the Montane and, occasionally, Lower Subalpine Ecoregions. It inhabits shrubby alluvial areas. On migration it frequents a variety of shrubby and disturbed sites" (Holroyd and Van Tighem 1983).

In KNP, it has been most often observed in dwarf birch and willow (S1) shrublands.

LINCOLN'S SPARROW *Melospiza lincolnii* LISP

STATUS AND DISTRIBUTION

Lincoln's Sparrow occurs across most of southern Canada excluding extreme southwestern B.C., the treeless plains, and southern Ontario (Godfrey 1966).

Munro and Cowan (1944) reported a singing male from a slide about five miles south of Vermilion Crossing on 24 June 1943.

Lincoln's Sparrow is a common but local summer resident of KNP. The earliest spring record is from 16 May 1983 along the shore of Dog Lake (RMW). "Autumn migration is during August" (Holroyd and Van Tighem 1983) . The latest observation is one from the warden's headquarters in Sinclair Canyon on 22 August 1983 (RMW). Lincoln's Sparrows are seen singly or in pairs.

There are four nesting records: a pair with a nest was observed at Dolly Varden Cr. on 28 June 1977 (KVT); a nest was located near the Conservation Corps pond in June 1982 (MMP); a nest with five eggs was found in a small wetland area below Kootenay Viewpoint on 8 June 1983 (RMW); and at least four fledged young were seen with adults along Dolly Varden Cr. on 24 July 1983 (RMW). A total of 24 was recorded on 605 circular bird plots.

HABITAT

Lincoln's Sparrow prefers marshy areas in the Montane and Lower Subalpine Ecoregions. It can be found in most valley bottom wetland areas in KNP. They are also found in the shrubby regions of some avalanche slopes and burns.

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=.02), followed by the Lower Subalpine Ecoregion (DI=.01). Ecosites on which the highest densities of this species occur are: AT4(.14), AL4(.13), VL6(.08), and DR6(.07).

The most important vegetation types are: dwarf birch-shrubby cinquefoil-willow/brown moss (S1) shrubland (.23), spruce/Labrador tea/brown moss (O11) open forest (.13), and lodgepole pine/twinflower-fireweed (S5) burns (.05).

GOLDEN-CROWNED SPARROW *Zonotrichia atricapilla* GOSP

STATUS AND DISTRIBUTION

In Canada, the Golden-crowned Sparrow occurs in southern Yukon, B.C., except for the southeast corner, and the mountatins of west-central Alberta (Godfrey 1966).

There is only one record of this species for KNP. A male was observed singing from the top of a small krummholz island in Kindersley Pass on 23 July 1981 (RMW). It is not likely to occur regularly in this park because it is slightly out of its normal range.

The Golden-crowned Sparrow is a fairly common summer resident and uncommon migrant in northern BNP and JNP (Holroyd and Van Tighem 1983) . "Autumn migration occurs in late July and August" (Holroyd and Van Tighem 1983) . It is probable that the KNP record was a post-breeding wanderer or an early migrant.

HABITAT

"The Golden-crowned Sparrow breeds in the Upper Subalpine Ecoregion and the lower edge of the Alpine" (Holroyd and Van Tighem 1983) . It prefers meadows where there are subalpine fir and Engelmann spruce krummholz islands.

WHITE-CROWNED SPARROW *Zonotrichia albicollis* WCSP

STATUS AND DISTRIBUTION

In Canada, the White-crowned Sparrow breeds throughout eastern B.C, southwestern Alberta, the Cypress Hills of Saskatchewan and Alberta, and across the northern regions to Newfoundland. On migration it may occur throughout southern Canada (Godfrey 1966).

Munro and Cowan (1944) reported a pair "established on a nesting territory" in the Kootenay Crossing burn in late June 1943.

The White-crowned Sparrow is an uncommon summer resident of KNP. Spring migration occurs in late April and May, peaking in mid-May. The earliest spring observations are of a "small flock" from the Redstreak area on 30 April 1981 (LRH) and an individual from the Mt. Wardle area on 30 April 1982 (DMP). "Autumn migration is in August and September" (Holroyd and Van Tighem 1983) . The latest autumn record is one from Marble Canyon on 11 September 1979 (LRH). White-crowned Sparrows are usually encountered singly or in pairs but on migration may be seen in small flocks of up to five.

There are three nesting records: a nest was found on the avalanche slopes of Mt. Whymper on an unspecified date during 1975 (Van Tighem 1977); a nest with three eggs was found on a vegetated Kootenay River sandbar near McLeod Meadows on 21 July 1976 (naturalist files); a fledged young was seen at the Stanley Glacier parking lot on 24 July 1976 (naturalist files). A total of 29 was recorded on 605 circular bird plots.

HABITAT

The White-crowned Sparrow inhabits shrubby areas on avalanche slopes, open Subalpine forests and floodplains from valley bottom to timberline, being most common in the Upper Subalpine Ecoregion.

The highest density, based on circular bird census plot samples, is in the Upper Subalpine Ecoregion (DI=.02), followed by the Lower Subalpine Ecoregion (DI=.01). Ecosites on which the highest densities of this species occur are: FV5(.21), WH8(.11), SB1(.08), PL4(.06), and SX1(.03).

The most important vegetation types are: willow/hairy wild rye (S12) shrubland (.64), Engelmann spruce-subalpine fir/willow/ribbed bog moss (O6) open forest (.13), subalpine larch-subalpine fir/heather (O13) open forest (.03), heather-everlasting (L5) heath meadow (.03), and lodgepole pine/twinflower-fireweed (S5) burns (.01).

DARK-EYED JUNCO *Junco hyemalis* DAJU

STATUS AND DISTRIBUTION

The Dark-eyed Junco nests throughout the forested regions of Canada (Godfrey 1966).

Munro and Cowan (1944) reported the Dark-eyed Junco as "abundant along highway and in clearings in semi-open woods" and said" several nests were seen" on 21 and 29 June 1943.

The Dark-eyed Junco is a common and widespread summer resident and rare winter visitor in KNP. Spring migration occurs from mid-March to mid-May, peaking in late April. The earliest record is from the Redstreak area on 10 March 1981 (LRH). The maximum count is 104 from a Kootenay valley migration survey on 27 April 1982 (MMP). "Autumn migration lasts from mid-August to late October, peaking in September" (Holroyd and Van Tighem 1983) The latest record is of eight from the Redstreak campground on 23 October 1965 (Seel 1965).

The Dark-eyed Junco occasionally winters in the Columbia valley and rarely visits the Redstreak area of the park. One was seen on 18 December 1980 (LRH), two were observed on 13 January 1981 (LRH), and seven were counted on 7 February 1965 (Seel 1965).

There are many breeding records for the park. The earliest is a nest with four eggs that was found near Settler's beaverponds on 30 May 1981 (KVT, RMW). The earliest fledged young were observed at Redstreak on 13 July 1965 (Seel 1965). A total of 568 was recorded on 605 circular bird plots.

HABITAT

The Dark-eyed Junco is found from valley bottoms to timberline and inhabits all types of forests and forest openings.

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=.30), followed by the Lower Subalpine Ecoregion (DI=.22). Ecosites on which the highest densities of this species occur are: HD3(.58), DR4(.53), DR7(.51), EG2(.51), and WY1 (.48).

The Dark-eyed Junco occurs at its highest densities in the following vegetation types: Engelmann spruce-subalpine fir/valerian-fleabane (O9) open forest (.53), lodgepole pine/twinflower-fireweed (S5) burns (.49), Douglas fir-ponderosa pine/wheatgrass (O24) open forest (.39), lodgepole pine/buffaloberry/pine grass (C38) forest (.38), Engelmann spruce-subalpine fir/willow/ribbed bog moss (O6) open forest (.38), Douglas fir/hairy wild rye (C1) forest (.37), spruce/Labrador tea/brown moss (O11) open forest (.37), spruce-aspen-lodgepole pine (paper birch)/buffaloberry/pine grass (C44) forest (.31), Engelmann spruce-subalpine fir/false azalea (C14) forest (.24).

SNOW BUNTING *Plectrophenax nivalis* SNBU

STATUS AND DISTRIBUTION

The Snow Bunting breeds in the high arctic and is a winter visitor across southern Canada (Godfrey 1966).

The Snow Bunting is an uncommon migrant in KNP. "Autumn migration occurs in October and November" (Holroyd and Van Tighem 1983) . The earliest record is of three flocks in the Kootenay valley on 22 October 1980 (LRH). Spring migration occurs in March (Holroyd and Van Tighem 1983) . The latest record is from a gravel pit in the Kootenay valley on 17 March 1979(park wildlife cards).

In BNP and JNP the species is a rare migrant and common winter resident (Holroyd and Van Tighem 1983) . Wade (1977) calls the Snow Bunting a regular winter resident of YNP. This species regularly winters in the Columbia valley outside the park.

HABITAT

In migration and winter the Snow Bunting frequents grasslands, weedy fields, grain stubble, roadsides, and feedlots (Godfrey 1966).

RED-WINGED BLACKBIRD *Agelaius phoeniceus* REBL

STATUS AND DISTRIBUTION

The Red-winged Blackbird occurs throughout B.C. and across southern Canada to Newfoundland (Godfrey 1966).

The Red-winged Blackbird is a common but local summer resident of KNP. It occurs around ponds throughout the Kootenay valley during the breeding season. On migration it is often seen "in mixed flocks of blackbirds along" Highway 93. The earliest spring record is of one female at Sora Pond on 4 May 1981 (LRH). The latest autumn record is of two females at Daer Pond on 16 September 1982 (DMP).

There are several nesting records from Dog Lake, Sora Pond, and Daer Pond. The earliest is a nest containing three eggs at Sora Pond on 10 June 1981 (RMW) and the latest a nest with five eggs at Daer Pond on 8 July 1981 (RMW). Fledged young have been observed commonly until August. A total of three was recorded on 605 circular bird plots.

HABITAT

The Red-winged Blackbird nests at "freshwater marshes and water edges which have thick growths of cattails, bulrushes, sedges, and similar vegetation and in bushes and small trees on water margins" (Godfrey 1966). In KNP it has only been found in the Montane Ecoregion on alluvial wetlands and along shallow pond edges. It is most common in dwarf birch-shrubby cinquefoil-willow/brown moss (S1) wetlands (VL2, DR6).

WESTERN MEADOWLARK *Sturnella neglecta* WEME

STATUS AND DISTRIBUTION

The Western Meadowlark occurs throughout southern B.C., excluding the high mountain regions, and across southern Canada to southern Ontario and Quebec (Godfrey 1966).

Munro and Cowan (1944) observed an individual near Marble Canyon during April 1937.

The Western Meadowlark is an uncommon migrant and rare summer visitor to KNP. Eleven of 13 records are from along Highway 93 from March to early May, the species main spring migration period (Holroyd and Van Tighem 1983) . There are only two other records: one from Stoddart Cr. on 10 June 1982 (GLH) and one from McLeod Meadows on 2 June 1970 (naturalist files). This species has been observed singly or in pairs.

There is no breeding evidence for the park. Only the Stoddart Cr. grasslands provide suitable nesting habitat for this species. A total of one was recorded on 605 circular bird plots.

HABITAT

The Western Meadowlark is a common resident of open grasslands and fields in the Columbia valley, outside the park. There is one record from the Stoddart Cr. grasslands (WY2, O24) of KNP (GLH). All other records are from disturbed habitats such as road surfaces and man-made grasslands. They are all from the Montane and Lower Subalpine Ecoregions.

YELLOW-HEADED BLACKBIRD *Xanthocephalus xanthocephalus* YEBL

STATUS AND DISTRIBUTION

The Yellow-headed Blackbird occurs across parts of southern Canada from western B.C. to western Ontario (Godfrey 1966).

The Yellow-headed Blackbird is a rare summer visitor to KNP, having been observed only four times. A female and immature male were seen at Vermilion Crossing with a flock of cowbirds on 31 May 1976 (naturalist files), two males were sighted near Crook's Meadow on 31 May 1977 (KVT), an adult male was observed at Sundew Pond on 30 June 1981 (RMW), and a pair was seen at the gravel pit near the Conservation Corps camp on 16 June 1982 (DMP).

There is no breeding evidence for KNP. A search of Sundew Pond on 30 June 1981 revealed no females so it is likely that the male (see above) was just a vagrant (RMW).

HABITAT

Nesting habitat for this species includes "deeper sloughs, wet marshes, and lake edges where there is adequate emergent vegetation" (Godfrey 1966). They are a common breeder in the extensive cattail marshes of the Columbia valley.

In KNP the Yellow-headed Blackbird has occurred three times in disturbed roadside habitats and once in a dwarf birch-willow (S1) shrubland.

RUSTY BLACKBIRD *Euphagus carolinus*

RUBL

STATUS AND DISTRIBUTION

The Rusty Blackbird breeds from the northern Yukon to NWT across northcentral Canada to the Atlantic provinces. It occurs throughout north and central B.C. (Godfrey 1966).

There is one record for this species in KNP during autumn migration. On 20 October 1981 a male Rusty Blackbird was sighted in flooded regenerating spruce on the southwest shore of Dog Lake (MMP).

The Rusty Blackbird is a rare migrant in KNP, just as it is in BNP and JNP (Holroyd and Van Tighem 1983) .

BREWER'S BLACKBIRD *Euphagus cyanocephalus*

BRBL

STATUS AND DISTRIBUTION

Brewer's Blackbird occurs across southern Canada from western B.C. to southern Ontario (Godfrey 1966).

This rare migrant was not reported for the park until 29 May 1979 when three were observed at Sora Pond (LRH). There are only six other records, all from the Kootenay valley, the earliest being of a male from near Kootenay Crossing on 23 April 1982 (LRH, MMP) and the latest on 15 June 1981 of four birds near the Settler's Road junction (LRH). There are no nesting records.

HABITAT

"Brewer's Blackbird inhabits shrubby alluvial meadows in the Montane and Lower Subalpine Ecoregions; it sometimes occurs on shrubby slopes. On migration it is also found in disturbed areas, including roadsides, landfills and corrals" (Holroyd and Van Tighem 1983) .

In KNP there are four observations from disturbed sites and one from a wet sedge (H11) meadow.

BROWN-HEADED COWBIRD *Molothrus ater*

BRCO

STATUS AND DISTRIBUTION

The Brown-headed Cowbird occurs throughout most of southern Canada (Godfrey 1966).

Munro and Cowan (1944) reported "several" with the horses at the Kootenay Crossing pasture during the summer of 1943.

The Brown-headed Cowbird is an uncommon summer resident of KNP. The earliest record is of one from the roadside in the lower Kootenay valley on 11 May 1982 (MMP). Flocks of 20 are not uncommon and the maximum is 55 from McLeod Meadows on 16 May 1976 (naturalist files). "Autumn migration occurs from early August to mid-September" (Holroyd and Van Tighem 1983) .

Van Tighem (1977) states that "immature cowbirds appear now and then in late July and August." On 19 July 1983 a pair of robins was observed feeding a fledgling cowbird near the second Kootenay Pond (RMW). A total of 29 was recorded on 605 circular bird plots.

HABITAT

The Brown-headed Cowbird prefers "alluvial wetlands with deciduous shrubbery or forest and, to a lesser extent, other deciduous or mixed forest" (Holroyd and Van Tighem 1983) . It is also often found in disturbed areas of the Montane and Lower Subalpine Ecoregions, particularly during migration.

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=.06), followed by the Lower Subalpine Ecoregion (DI=.02). Ecosites on which the highest densities of this species occur are: FR3(.23), AT1(.18), BY4(.15), and VL6(.14).

Highest densities occur in open areas and disturbed parts of white spruce-subalpine fir/bunchberry-horsetail (C41)(.41), lodgepole pine/buffaloberry/twinflower (C19)(.38), and lodgepole pine/buffaloberry/pine grass (C38)(.10) closed forests.

ROSY FINCH *Leucosticte arctoa* GRFI

STATUS AND DISTRIBUTION

In Canada, the Rosy Finch breeds throughout western and southern B.C., the Yukon, and the mountains of southwestern Alberta (Godfrey 1966).

The Rosy Finch is a common summer resident of KNP. Spring migration is from mid-April until early May. The earliest record is of a flock of 50 from the lower Kootenay valley on 21 April 1982 (MMP). There are only two autumn records although it is undoubtedly more common. On 4 and 6 October 1982 flocks of 50 and 100 birds were observed in Wolverine Pass (MMP).

There are three nesting records: a fledgling was observed near Wolverine Pass on 26 July 1982 (MMP) and two broods of two fledglings were seen in Goodsir Pass on 25 July 1982 (DMP). A total of 87 was recorded on 605 circular bird plots.

HABITAT

During the breeding season "it is most common in tundra and heath meadows at and above timberline and, less commonly, on grassy avalanche slopes and talus or other colluvial debris" (Holroyd and Van Tighem 1983) . On migration it is most often encountered in disturbed sites along Highway 93.

The highest density, based on circular bird census plot samples, is in the Alpine Ecoregion (DI=.47), followed by the Upper Subalpine Ecoregion (DI=.34). Ecosites on which the highest densities of this species occur are: SX1(1.16), BP2(.86), BS2(.86), and EG4(.72).

The most important vegetation types are: heather-everlasting (L5) heath tundra (1.21), mountain avens-snow willow-moss campion (H1) tundra (.76), subalpine larch-subalpine fir/heather (O13) open forest (.40), and subalpine larch-subalpine fir/grouseberry-everlasting (C23) closed forest (.29).

PINE GROSBEAK *Pinicola enucleator* PIGR

STATUS AND DISTRIBUTION

The Pine Grosbeak occurs throughout B.C., Yukon, the northern parts of the prairie provinces, and the forested regions of eastern Canada (Godfrey 1966).

The Pine Grosbeak is a common permanent resident of KNP. During the breeding season it is most often encountered singly or in pairs, but during the winter it is more often seen in flocks of five to ten individuals. The maximum count is 30 from near the Redstreak campground on 15 December 1965 (Seel 1965).

There are three breeding records: a pair building a nest was observed near Cobb Lake (naturalist files), fledglings were seen along Ochre Cr. (KVT), and at least two fledglings were seen in the Vermilion Pass burn on 20 July 1983 (RMW). A total of 52 was recorded on 605 circular bird plots.

HABITAT

During the breeding season the Pine Grosbeak is most commonly observed in subalpine coniferous forests but is also seen in Montane Ecoregion mixed and coniferous forests. "In the winter, some birds move into coniferous forests of the Montane Ecoregion and to inhabited areas where they often feed on the seeds of ornamental trees (Holroyd and Van Tighem 1983) .

The highest density, based on circular bird census plot samples, is in the Subalpine Ecoregion (DI=.07), followed by the Montane Ecoregion (DI=.03). Ecosites on which the highest densities of this species occur are: SB6(.78), DG6(.39), EG1(.26), and EG3(.21).

The most important vegetation types are: Engelmann spruce-subalpine fir/rock willow/bracted lousewort (O14) open forest (.16), Engelmann spruce-subalpine fir/false azalea (C14) closed forest (.11), Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) closed forest (.10), subalpine larch-subalpine fir/grouseberry-everlasting (C23) closed forest (.08), and Engelmann spruce-subalpine fir/green alder (C25) closed forest (.08).

PURPLE FINCH *Carpodacus purpureus* PUFI

STATUS AND DISTRIBUTION

The Purple Finch "breeds across wooded parts of Canada from B.C. (except interior southern part) east to Newfoundland" (Godfrey 1966).

The Purple Finch is an uncommon summer resident of KNP. "Spring migration is in late April and May" (Holroyd and Van Tighem 1983) . The earliest migrant is a male seen near the Redstreak campground on 27 April 1981 (LRH). The maximum count is eight from Crook's Meadow area on 24 May 1983 (CWS). "Autumn migration occurs in August" (Holroyd and Van Tighem 1983) .

The Purple Finch occasionally winters in the Columbia valley; on 4 January 1981 a total of 28 were observed during the Lake Windermere Christmas bird count (LRH).

There are no nesting records but a female with nesting material was observed near the Shank's fire road on 6 June 1983 (MMP). A male was heard in the same area so it is very probable that at least one pair nested here. They probably nest more commonly in the extensive mixed woodland of the Kootenay valley. A total of four was recorded on 605 circular bird plots.

HABITAT

The Purple Finch is seen almost exclusively in the Montane Ecoregion but is occasionally observed in the Lower Subalpine Ecoregion as well. It has also been observed in spruce/fir (C14, 04) forest on the edge of avalanche slopes, pine/spruce (C38) forest of the Kootenay valley, and on dry, aspen-dominated (S16) slopes.

CASSIN'S FINCH *Carpodacus cassinii* CAFI

STATUS AND DISTRIBUTION

In Canada, Cassin's Finch breeds in southern interior B.C. to Waterton Lakes National Park in extreme southwestern Alberta (Godfrey 1966).

Munro and Cowan (1944) reported a male from the Hot Springs area on 29 June 1943.

Cassin's Finch is a rare and local summer resident of the extreme southern portion of the park. The earliest record and maximum count is of at least six from Stoddart Cr. on 26 May 1983 (CWS). At least three males were singing on territories in the same vicinity on 4 June 1982 (KVT). All records are from May to July.

There are no nesting records although the species likely breeds at Stoddart Cr. due to the presence of singing males every year. A total of 15 was recorded on 605 circular bird plots.

HABITAT

Cassin's Finch prefers "open coniferous forests in the western mountains ranging up to considerable altitudes" (Godfrey 1966).

In KNP, Cassin's Finch is most common within the Montane Ecoregion, in the Douglas fir open forest (DG3, WY2; 024, C1, 05) of the Stoddart Cr. region. All observations during breeding bird surveys were from the WY2 (DI=.10) Ecosite. It has also been found, uncommonly, on higher elevation, dry open slopes (SB3, WF3; 04, 05) of the Lower Subalpine and Upper Subalpine Ecoregions.

RED CROSSBILL *Loxia curvirostra* RECR

STATUS AND DISTRIBUTION

In Canada, the Red Crossbill breeds throughout B.C., mountainous southwestern Alberta, and across the boreal forest to Newfoundland (Godfrey 1966).

Munro and Cowan (1944) reported three from a "pine grove" near Kootenay Crossing on 28 June 1943.

The Red Crossbill is a widespread but uncommon permanent resident of KNP. They are usually observed in flocks of five to ten although larger flocks are not uncommon. The maximum count is a flock of 20 from the base of Mt. Wardle on 10 June 1983 (MMP). The numbers of this species fluctuate greatly and in years of good cone crops (as in 1983) they may be quite abundant locally.

There are no breeding records but this species likely nests in numerous localities within the park. A total of 27 was recorded on 605 circular bird plots.

HABITAT

The Red Crossbill is most commonly found in coniferous and coniferous/deciduous forest, especially where pine or Douglas fir dominates. They occur from valley bottoms to timberline but are most common in the Montane Ecoregion. When there is a poor cone year these birds may be seen feeding in large numbers on ornamental shrubbery and along roadsides during the winter.

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=.08), followed by the Subalpine Ecoregion (DI=.01). Ecosites on which the highest densities of this species occur are: DR4(.69), DR6(.37), FR3(.22), BP2(.12), and AT1(.11).

The most important vegetation types are: spruce-aspen-lodgepole pine (paper birch)/buffaloberry/pine grass (C44) closed forest (.23), Douglas fir/hairy wild rye (C1) closed forest (.21), and lodgepole pine/buffaloberry/pine grass (C38) closed forest (.20).

WHITE-WINGED CROSSBILL *Loxia leucoptera* WHCR

STATUS AND DISTRIBUTION

The White-winged Crossbill occurs across the forested regions of Canada (Godfrey 1966).

The White-winged Crossbill is a widespread but uncommon permanent resident of KNP. They are usually observed in small flocks of up to ten birds but larger flocks are not uncommon. The maximum count is of a flock of 50 seen on Vermilion Peak on 4 June 1983 (RMW). Like the Red Crossbill, this species is prone to population fluctuations.

There are no nesting records but it likely nests in high elevation coniferous forests throughout the park. A total of 13 was recorded on 605 circular bird plots.

HABITAT

The White-winged Crossbill prefers coniferous woodland, usually at higher elevations than the Red Crossbill and, especially, those dominated by spruce/fir and larch. It is not as common in disturbed sites as the Red Crossbill.

The highest density, based on circular bird census plot samples, is in the Upper Subalpine Ecoregion (DI=.06), followed by the Lower Subalpine Ecoregion (DI=.03). Ecosites on which the highest densities of this species occur are: EG1(.21), WH1(.21), and PL1(.09).

The most important vegetation types are: Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) closed forest (.09), heather-everlasting (L5) heath tundra (.09), and subalpine larch-subalpine fir/heather (O13) open forest (.04).

COMMON REDPOLL *Carduelis flammea* CORE

STATUS AND DISTRIBUTION

The Common Redpoll breeds throughout the arctic and winters in fluctuating numbers throughout most of southern Canada (Godfrey 1966).

The first park record was of 30 from the Redstreak area on 24 November 1965 (Seel 1965).

The Common Redpoll is an uncommon winter resident in KNP. The earliest autumn record is the above record from 24 November 1965. The latest spring record is of two from the lower Kootenay valley on 1 May 1982 (DMP). Most observations were of flocks of five to ten but larger ones were not uncommon. The maximum count is about 40 from the Kootenay Viewpoint on 27 January 1982 (MMP).

The Common Redpoll is common in the Columbia valley during the winter and a count of 461 was obtained on the 1981 Lake Windermere District Christmas bird count (LRH). Johnstone (1949) calls it an "irregular winter visitant" to the East Kootenays. Wade (1977) considers it a "fairly common winter resident" in Yoho National Park. In BNP and JNP the Common Redpoll is a common migrant and winter resident

(Holroyd and Van Tighem 1983) .

HABITAT

In winter and migration the Common Redpoll "occurs most commonly in alluvial areas, roadsides and disturbed areas in the Montane and Lower Subalpine Ecoregions" (Holroyd and Van Tighem 1983) . It frequents "meadows, alder thickets, tall shrubbery, forest edges" (Holroyd and Van Tighem 1983) , and weed patches. "It is especially fond of the seeds of birch and alder" (Godfrey 1966).

PINE SISKIN *Carduelis pinus* PISI

STATUS AND DISTRIBUTION

The Pine Siskin breeds in forested regions throughout Canada (Godfrey 1966).

Munro and Cowan (1944) reported the Pine Siskin as common in small flocks of five to six from Sinclair Canyon to Vermilion Crossing.

The Pine Siskin is a common and widespread summer resident of KNP. Spring migration "occurs from mid-March to late May, peaking in mid-to late May" (Holroyd and Van Tighem 1983) . The earliest record is one from the Redstreak benchlands on 18 March 1981 (LRH). "Autumn migration occurs from mid-August to early November peaking from late August to mid-September" (Holroyd and Van Tighem 1983) . The latest record is of one near Swede Cr. on 28 October 1981 (MMP). The Pine Siskin is usually seen in small flocks of up to ten. The maximum count is 30 in Ottertail Pass on 28 June 1983 (MMP).

There are no nesting records although the species is undoubtedly a common breeder in the park.

The Pine Siskin is a regular winter resident in the Columbia valley outside the park. On the 1980 Lake Windermere District Christmas bird count 49 were seen (LRH). In BNP and JNP the Pine Siskin is a rare winter resident (Holroyd and Van Tighem 1983) . A total of 564 was recorded on 605 circular bird plots.

HABITAT

The Pine Siskin is seen from valley bottom to above timberline, where it inhabits all forest types. It is most common in subalpine coniferous forest. On migration it may be seen in disturbed sites such as roadsides, ornamental shrubbery, and man-made meadows.

The highest density, based on circular bird census plot samples, is in the Upper Subalpine Ecoregion (DI=.25), followed by the Lower Subalpine Ecoregion (DI=.23). Ecosites on which the highest densities of this species occur are: HD3(.48), AL3(.48), SB3(.48), BP2(.45), WH6(.41), and BY7(.40).

The Pine Siskin occurs in its highest densities in the following vegetation types: dwarf birch-shrubby cinquefoil-willow/brown moss (S1) wet shrubland (.50), Engelmann spruce-subalpine fir/rock willow/bracted lousewort (O14) open forest (.45), Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) forest (.39), lodgepole pine/green alder/feathermoss (C10) forest (.36), Douglas fir/juniper/bearberry (O5) open forest (.32), Engelmann spruce-subalpine fir/heather (O10) open forest (.32), subalpine larch-subalpine fir/grouseberry-everlasting (C23) forest (.30), Engelmann spruce-subalpine fir/false azalea (C14) forest (.28), lodgepole pine/false azalea/grouseberry (C20) forest (.25).

AMERICAN GOLDFINCH ***Carduelis tristis*** **AMGO**

STATUS AND DISTRIBUTION

The American Goldfinch breeds across southern Canada from coast to coast (Godfrey 1966).

The American Goldfinch is a rare migrant in KNP. There are two records: single males were observed at Kootenay Pond on 11 May and 2 June 1981 (RMW).

The American Goldfinch is a rare migrant and summer visitor in BNP and JNP (Holroyd and Van Tighem 1983) . It is considered "occasional" in the Wilmer Wildlife Area (Simpson and Kelsall 1978). It winters irregularly in the Columbia valley. Eight were seen on the 1980 Lake Windermere District Christmas bird count but they were not observed on the 1981 and 1982 counts (LRH).

HABITAT

The American Goldfinch prefers "... roadsides and open weedy places not too far from wood edges or patches, second growths, tall shrubs... (and) open deciduous woods or shrubs" (Godfrey 1966). The KNP record is from an open area in the mixed (C44) forest of the Montane Ecoregion.

EVENING GROSBEAK ***Coccothraustes vespertinus*** **EVGR**

STATUS AND DISTRIBUTION

The Evening Grosbeak breeds throughout the southern half of B.C., the southwestern mountains and northern half of Alberta, and locally across the rest of southern Canada to Nova Scotia (Godfrey 1966).

Munro and Cowan (1944) saw five at Vermilion Crossing, six at Dolly Varden Cr., and a pair near Settler's road between 12 and 24 June 1943.

The Evening Grosbeak is a common summer resident of KNP. The earliest record is three from the Nixon Lake trailhead on 30 May 1981 (RMW, KVT). The latest record and maximum count is nine from the Kimpton Cr. trail on 29 August 1979 (LRH). The Evening Grosbeak is usually seen in small flocks of up to five.

There are no nesting records but the species probably breeds in the park.

There are no winter records but observations from the lower Kootenay valley can be expected. The species is common throughout the Columbia valley in the winter. They have been observed on all Christmas bird counts in the area. A maximum count of 250 was obtained on the 1980 count (LRH). The Evening Grosbeak is an uncommon winter resident in the townsites of Banff and Jasper (Holroyd and Van Tighem 1983) . A total of 76 was recorded on 605 circular bird plots.

HABITAT

The Evening Grosbeak occurs in the Montane and Lower Subalpine Ecoregions where it prefers "open coniferous forests and forest edges" (Holroyd and Van Tighem 1983) .

The highest density, based on circular bird census plot samples, is in the Montane Ecoregion (DI=.03), followed by the Lower Subalpine Ecoregion (DI=.02). Ecosites on which the highest densities of this species occur are: DR7(.10), BY7(.08), DR2(.07), VL6(.06), and BY1(.05).

The most important vegetation types are: lodgepole pine/green alder/feathermoss (C10) closed forest (.17), green alder/fern (S13) closed forest (.16), lodgepole pine/false azalea/grouseberry (C20) closed forest (.06), Engelmann spruce-subalpine fir/green alder (C25) closed forest (.02), and Engelmann spruce-subalpine fir/false azalea (C14) closed forest (.02).

HOUSE SPARROW *Passer domesticus* HOSP

STATUS AND DISTRIBUTION

The House Sparrow was introduced to North America in the 1850's and has become widely established. It inhabits most settled areas of Canada (Godfrey 1966).

The House Sparrow is a rare summer visitor to KNP. The only record is of a pair from Redstreak campground on 1 August 1965 (Seel 1965). This species is common around the towns of the Columbia valley. It is most likely to occur around the settled areas of Sinclair Canyon.

HABITAT

The House Sparrow inhabits areas in "...the vicinity of human buildings and cultivated land..." (Godfrey 1966). In KNP, the only record is from a disturbed area in the Montane Ecoregion.

MANAGEMENT CONSIDERATIONS

The House Sparrow is an exotic species which should not be allowed to flourish in the park. It is a very aggressive species that usurps native species' nesting sites. Since the House Sparrow nests early, it takes most of the favourable nesting areas. It is possible to at least partially alleviate the problem by plugging up nest holes and boxes until the spring migrants have returned (Holroyd and Van Tighem 1983) .

4.4 MAMMALS

The mammal fauna of KNP includes 57 species. The following species accounts are based on wildlife inventory data as well as information from several other sources. Nomenclature, general distribution and habitat information is from Banfield (1974) and Cowan and Guiguet (1965). Regional information is from B.C. Fish and Wildlife Branch Preliminary Management Plans and Holroyd and Van Tighem (1983). The historical status of most species in the park is poorly documented, however two reports (Cowan 1943; Munro and Cowan 1944) based on field work in KNP in 1943 provide a benchmark for most species. More recent studies by Stelfox (1966, 1971, 1976, 1978) Holroyd (1967), DeBock (1970), Gibbons and Baker (1976), Gibbons (1978) and Sheehan and Peers (1979) provide historical status information for ungulates in the park. Other sources of information were the Public Archives in Ottawa, Parks Canada naturalist and warden files, Superintendent's reports and the park wildlife cards information stored in the Ottawa CANSIS computer facility.

Habitat information is largely based on sampling conducted during this inventory. Ecosite and vegetation type symbols (*eg.* WY1, C1) refer to detailed descriptions in Volume I (Achuff *et al.* eds. 1984). Complete habitat importance rankings and descriptions of Small Mammal Associations (SMA) are also in Volume I (Poll and Porter 1984, Walker *et al.* 1984).

MASKED SHREW *Sorex cinereus* MASH

STATUS AND DISTRIBUTION

The masked shrew is widespread and abundant throughout Canada and all of mainland B.C.

The masked shrew is widespread but uncommon in KNP. Most researchers capturing small mammals in KNP have captured masked shrews but always in low numbers: Munro and Cowan (1944); 3; Reid (1972); 4; Fitzmartyn (1973); 3; Gray (1975); 2. and Trottier *et al.* (1977); 1. During the inventory, nine masked shrews (0.9% of all captures) were captured on seven of the 50 snap trap lines. The highest density found was 1.2 captures per 100 trap nights on two trap lines in late August (DR8, PP3; H11, C29). The highest average density was 0.4 captures per 100 trap nights in SMA 8.

HABITAT

The masked shrew is found from the Montane to the Upper Subalpine as high as 2010 m.

Other specimens have been captured in the Vermilion Pass burn (S5), in spruce/subalpine fir forest (Harris 1976) and in spruce/Douglas fir/ lodgepole pine forest (Trottier *et al.* 1976). It occurs in a wide variety of habitats from closed forests to open meadows. Masked shrews were trapped on DR3, DR7, DR8, and PP3, in lodgepole pine/buffaloberry/showy aster (C6) and lodgepole pine/Labrador tea (C29) forests, Engelmann spruce-subalpine fir/heather (O10) open forest, hairy wild rye-wild strawberry-fireweed (H5) avalanche meadows, dwarf birch-shrubby cinquefoil-willow/brown moss (S1) shrubland, and water sedge-beaked sedge (H11) wet meadows.

DUSKY SHREW *Sorex monticolus* DUSH

STATUS AND DISTRIBUTION

The dusky shrew is common and occurs throughout the forest, shrublands and mountains of western Canada.

This is the most common species of shrew in KNP. Munro and Cowan (1944) captured 5 dusky shrews in KNP. During the inventory 15 (1.6% of all captures) were snap trapped on eight of the 50 snap trap lines. The dusky shrew was also captured on the Verendrye live trap plot. The highest density based on snap-trapping was 2.2 captures per 100 trap nights in late August (Ecosite: SX1; v.t.: S4). The highest average density was 0.7 captures per 100 trap nights in SMA 8.

HABITAT

The dusky shrew occurs from the Montane to the Upper Subalpine with the highest elevational record at 2010 m. It occurs in a wide variety of habitats from closed forest to open meadows. During the inventory, highest densities were found on SX1 and DR3; other records were on PP3, WY2, DR2 and SB1. Based on snap-trapping results, the most important vegetation types include willow-dwarf birch/fleabane (S4) and wet dwarf birch-shrubby cinquefoil-willow/brown moss (S1) shrublands. It was also found commonly in coniferous forests (C29, C30), with an understory of Labrador tea, Engelmann spruce-subalpine fir/false azalea (C14) forests and Engelmann spruce-subalpine fir/heather (O10) open forests. Other records were obtained from Douglas fir-ponderosa pine/wheatgrass (O24) open forests, aspen/hairy wild rye-showy aster (C22) forests and avalanche slopes.

PYGMY SHREW *Sorex hoyi* PYSH

STATUS AND DISTRIBUTION

The pygmy shrew is found across Canada except on the tundra, prairies and west coast of B.C.

Prior to this inventory there were three records of the pygmy shrew from KNP and it can be considered rare. Two specimens were taken by Munro and Cowan (1944) at the Vermilion Crossing bungalows. One specimen was taken in 1973 in the Vermilion Pass burn (Fitzmartyn 1973). One specimen was captured near McLeod Meadows in early November 1981.

HABITAT

The usual habitat of the pygmy shrew is in forests although it can be found in a wide variety of habitats (van Zyll de Jong 1983). The specimens taken from KNP have been from spruce-aspen-lodgepole pine (paper birch)/buffaloberry/pine grass (C44) forest on AT4; from Engelmann spruce-subalpine fir/feathermoss (C13) forest and from disturbed white spruce-subalpine fir/bunchberry-horsetail (C41) forest.

WATER SHREW *Sorex palustris* WASH

STATUS AND DISTRIBUTION

The water shrew is widespread but uncommon in Canada. It is found throughout B.C.

In KNP, this species is rare and found only in its very specialized habitat. Munro and Cowan (1944) captured the only specimen known from KNP. No further records were obtained during the inventory although one may have been sighted at Cobb Lake (naturalists files).

HABITAT

The water shrew is a resident of small, clear streams and lake margins. The single specimen from KNP was caught along a small stream flowing through a spruce woods.

LITTLE BROWN BAT *Myotis lucifugus* LIBA

STATUS AND DISTRIBUTION

The little brown bat is distributed throughout North America, from central Alaska east through the NWT to Labrador, and south to Mexico. Its winter range in western Canada is unknown.

Little brown bats are restricted to the Sinclair and Stoddard watersheds of KNP. Their echolocation calls were detected at Radium Hot Springs (0.43 passes per minute), Olive Lake (0.60 passes per min.), west gate (1 per min.), Cobb Lake (5 per min.) and John McKay Cr. reservoir (1 pass). One was caught at the Palmer Cr. dam on the park boundary, one male at John McKay Cr. compound lights in August 1981 and nine at Cobb Lake. They are common and active around the lights at Redstreak campground during the summer.

The little brown bat is the commonest bat in the park but is not as widespread as the hoary bat and long-legged bat. Overall bat activity is relatively low. For example, bat activity in KNP for all species was 0.71 passes per minute (range 0 to 7) compared to 3-4 passes per minute (range 0 to 67) in southern Ontario (Fenton pers. comm.)

HABITAT

Little brown bats are restricted to the Montane Ecoregion in KNP and are rare and local even there. With the exception of Cobb Lake they were not detected in either the Kootenay or Vermilion watersheds. In the Sinclair watershed they occurred as high as Olive Lake (1276 m.).

We were not able to determine any specific habitat preferences beyond preference for water bodies (Cobb Lake, Olive Lake and John McKay Cr. reservoir). Little brown bats also feed around street lights, especially at the west gate, Redstreak campground and in Radium Hot Springs. Large trees likely provide sites for nursery colonies but buildings are also potential colony sites.

The patchy distribution of this species reflects its patchy food supply over open water and, possibly, a scarcity of appropriate roost trees for nursery colonies.

SPECIES ATTRIBUTES

Female little brown bats are colonial when they have young. Ovulation occurs in April or May and a single young is born between mid May and July (Schowalter *et al.* 1979). There is evidently a small colony of little brown bats near Cobb Lake. Nine were caught in mist nets on 17 July 1982. Since they were caught in a very short time and 7 of the 9 were lactating females it appeared that they came from a nearby nursery colony.

Little brown bats arrived in KNP in early May and were the last bats to leave in late September. This species hibernates in caves or mines where ambient temperatures are just above 0°C. It is unlikely that any hibernating sites occur in the park. However, there may be suitable sites in the Columbia valley.

Little brown bats eat soft-bodied insects such as mosquitoes and moths. These insects are likely most common over water bodies and by lights, which is where we found little brown bats most frequently. The little brown bat is clearly specialized for rapid feeding (Fenton and Bell 1979) as shown by observations from Cobb Lake. On 17 July 1981 at 2145 h. B. Fenton had three mist nets open and ready for bats on the shore of Cobb Lake. The first bat was detected via its echolocation calls at 2212 h. just before dusk. By 2220 h. four little brown bats had been caught in the mist nets, and those captured at this time (but not the one taken at 2213 h.) had stomachs fully distended with insects. Only little brown bats were detected at Cobb Lake.

MANAGEMENT CONSIDERATIONS

Day roosts have been reported in some of the campground shelters and are vulnerable to disturbance.

NORTHERN LONG-EARED BAT *Myotis septentrionalis* NOBA

STATUS AND DISTRIBUTION

The northern long-eared bat ranges through southeastern Canada to Alberta. There are records of this species west to Hudson Hope, B.C., and north to the southern NWT. This bat was previously considered to be *Myotis keenii* and a precise distribution is not presently known (van Zyll de Jong 1979). It was recently discovered in MRNP (van Zyll de Jong and Fenton 1980).

There are no northern long-eared bat records from KNP. The echolocation call cannot be accurately distinguished from the long-eared bat but it was suspected to be present from calls heard at Stoddard Cr. and Settlers Road in July 1981 and 1982 respectively. Northern long-eared bats were detected and caught in MRNP during 1979, 1981 and 1982 (Van Tighem and Gyug 1984).

HABITAT

If this species occurs in KNP it is limited to the Montane Ecoregion. Both tree cavities and buildings are used as colony sites. In winter northern long-eared bats hibernate in caves and mines.

LONG-EARED BAT *Myotis evotis* LEBA

STATUS AND DISTRIBUTION

The long-eared bat is found in western Canada from central B.C. to southwestern Saskatchewan (van Zyll de Jong 1979).

This species ranges widely in KNP. A small nursery colony was found in the lodge kitchen at Vermilion Crossing on 29 June 1943 (Munro and Cowan 1944) and long-eared bats were still present in 1982 although the existence of the colony could not be confirmed. Individuals were recorded during the inventory at

Kootenay Crossing, the base of Mt. Wardle and Kootenay Pond. Fewer than ten were observed at McLeod Meadows and near Stoddard Cr. Another was seen at the Nipika Touring Centre in the Kootenay valley south of the park.

Although widespread, the species is nowhere abundant. Their calls were detected at the rate of only 0.05 to 0.10 calls per minute. In 1981 long-eared bat calls represented 8% of the calls recorded.

HABITAT

This bat occurs in coniferous forests in the Montane and Lower Subalpine Ecoregions. The vegetation at all of the KNP sites is mixed conferous forest adjacent to open grasslands. In addition the lights of Radium and the Vermilion Crossing lodge attract long-eared bats which forage on insects concentrated there. Long-eared bats emerge late in the evening to forage adjacent to forest edges or in forests on moths, flies, beetles and other flying insects Buildings are often used as colony sites in summer while caves and mines are occupied during winter hibernation.

MANAGEMENT CONSIDERATIONS

Colonies in buildings should be protected since most of the park's long-eared bats likely use buildings. This species appears to be less dependent on street lights than other species of bats in KNP.

LONG-LEGGED BAT *Myotis volans* LOBA

STATUS AND DISTRIBUTION

In Canada this species occurs from the northern coast of B.C. across to central Alberta. It ranges as far south as Mexico.

The long-legged bat is rare in KNP. The only record is of one caught at the Palmer Cr. dam on the park boundary on 17 July 1982.

HABITAT

The only park record was in the Montane Ecoregion. The Palmer Cr. site is in a small canyon surrounded by deciduous forest and adjacent to open, dry Douglas fir forest and a golf course.

Long-legged bats feed 3 to 4 m. above water and in openings in the forest. In the Okanagan valley of B.C. they foraged above the tree canopy up to 10 m., and along the banks of the Okanagan River (Fenton *et al.* 1980). In Ontario, they feed under the tree canopy and follow the forest edge at the canopy level (Fenton and Bell 1979).

SPECIES ATTRIBUTES

Nursery colonies of up to several hundred bats are formed during the summer in trees, crevices or buildings. Caves may be used as night roost sites. One young is produced from late July to early August.

In northern areas, long-legged bats tend to occur alone or in small groups. The colonies disperse in the fall for migration.

CALIFORNIA BAT *Myotis californicus* CABA

STATUS AND DISTRIBUTION

The California bat is found in western North America from Prince Rupert, B.C. to central Mexico (Banfield 1974). California bats were common around Revelstoke in 1980 (van Zyll de Jong 1980).

California bats were encountered in 1981 and 1982 in KNP and the adjacent Columbia valley. Their calls were detected in late July at the John McKay Cr. reservoir (0.38 calls per minute) and at Stoddard Cr. (1.20 calls per minute). Two were trapped in a Tuttle Trap at the Palmer Cr. dam on 18 July 1982 and one was caught at the Wilmer Wildlife Area on 16 July 1982. In 1981 their calls represented 41% of the calls recorded. Within KNP California bats are restricted to the lower Sinclair Cr. and Stoddard Cr. watersheds.

HABITAT

California bats occur only in the driest portions of the Montane Ecoregion. The bats captured at Wilmer and Palmer Cr. were in open Douglas fir forest and grassland. The site at John McKay Cr. is surrounded by a mixed coniferous forest. All of the California bat records were over water, including both ponds and flowing streams.

SPECIES ATTRIBUTES

California bats exhibit a characteristic erratic flight pattern as they capture flies, small moths, and other insects, usually close to the ground.

Single young emerge during July within maternity roosts located in buildings, crevices, bridges, mines, trees or under bark. Buildings and open man-made shelters may be chosen for night roosts.

SILVER-HAIRED BAT *Lasionycteris noctivagans* SIBA

STATUS AND DISTRIBUTION

The silver-haired bat occurs across southern Canada as far north as the Peace River district and the Queen Charlotte Islands. The winter range extends from the west coast of B.C. to southern California, to the eastern U.S.A. Although scarce through much of its range, this species may occur more frequently in the northern Rocky Mountains.

An individual was captured in GNP, however studies in KNP produced no evidence of this species. A specimen road-killed near Mt. Wardle in 1968 is the only record from the park.

HABITAT

Silver-haired bats inhabit northern forests, where they forage over ponds and streams. The only park record was in the Montane Ecoregion. Day roosts may be in trees or under bark. Buildings, crevices, and, rarely, caves and mines are used for hibernation.

HOARY BAT *Lasiurus cinereus* HOBA

STATUS AND DISTRIBUTION

The breeding distribution of the hoary bat extends across Canada, and north through the boreal forest to the NWT. It ranges through all parts of the U.S.A., including Hawaii, south into South America.

In KNP, hoary bats are uncommon but widespread. Their echolocation calls were identified at the west gate, maintenance compound, Vermilion Crossing and two locations along the highway in between (Figure 4.1). They were also active at Wilmer Wildlife Area on 16 July 1982. Generally only one or two bats were present at a given location. A number of what were thought to be hoary bats were feeding above the trees at the West gate on 3 May 1983 (MMP). In 1981, hoary bat calls represented 18% of the bat activity we recorded.

HABITAT

This species has been recorded only in open areas in the Montane Ecoregion. Hoary bats prefer forests where they roost in the branches of trees. They apparently concentrate their feeding efforts around lights and in open habitats such as fields, ponds and in clearings in the forest (Holroyd 1983).

SPECIES ATTRIBUTES

Hoary bats are solitary and do not congregate like little brown bats. They forage later in the evening than other species; on 17 July 1982 hoary bats did not appear at the compound lights until 2232 h. showed a peak in activity around 2300 h. and were still feeding at 0100 h.

Since hoary bats roost in trees their numbers are not likely to be limited by availability of roosts. We noticed a considerable decline in activity below 10°C at the compound lights.

Hoary bats require large prey, typically moths. It seems likely that hoary bat distribution and abundance are limited by a combination of food accessibility and ambient air temperatures. Hoary bats arrive in KNP during the first week of May.

BIG BROWN BAT *Eptesicus fuscus*

STATUS AND DISTRIBUTION

BIBA

The big brown bat is found across southern Canada and as far north as Prince George in B.C. and Wood Buffalo National Park in Alberta (Banfield 1974). It is common throughout much of its range.

Big brown bats are very restricted in distribution in KNP. In July 1981 and 1982, they were detected at the maintenance compound, the lights in Redstreak campground and the west gate. One was caught at the entrance to a shallow cave at Stoddard Cr. and another at the maintenance compound. Outside the park, 22 were trapped at a nursery colony in the museum at Invermere and several were detected in Wilmer Wildlife Area. They are relatively uncommon in KNP; in 1981 their calls comprised only 5% of the total calls counted.

HABITAT

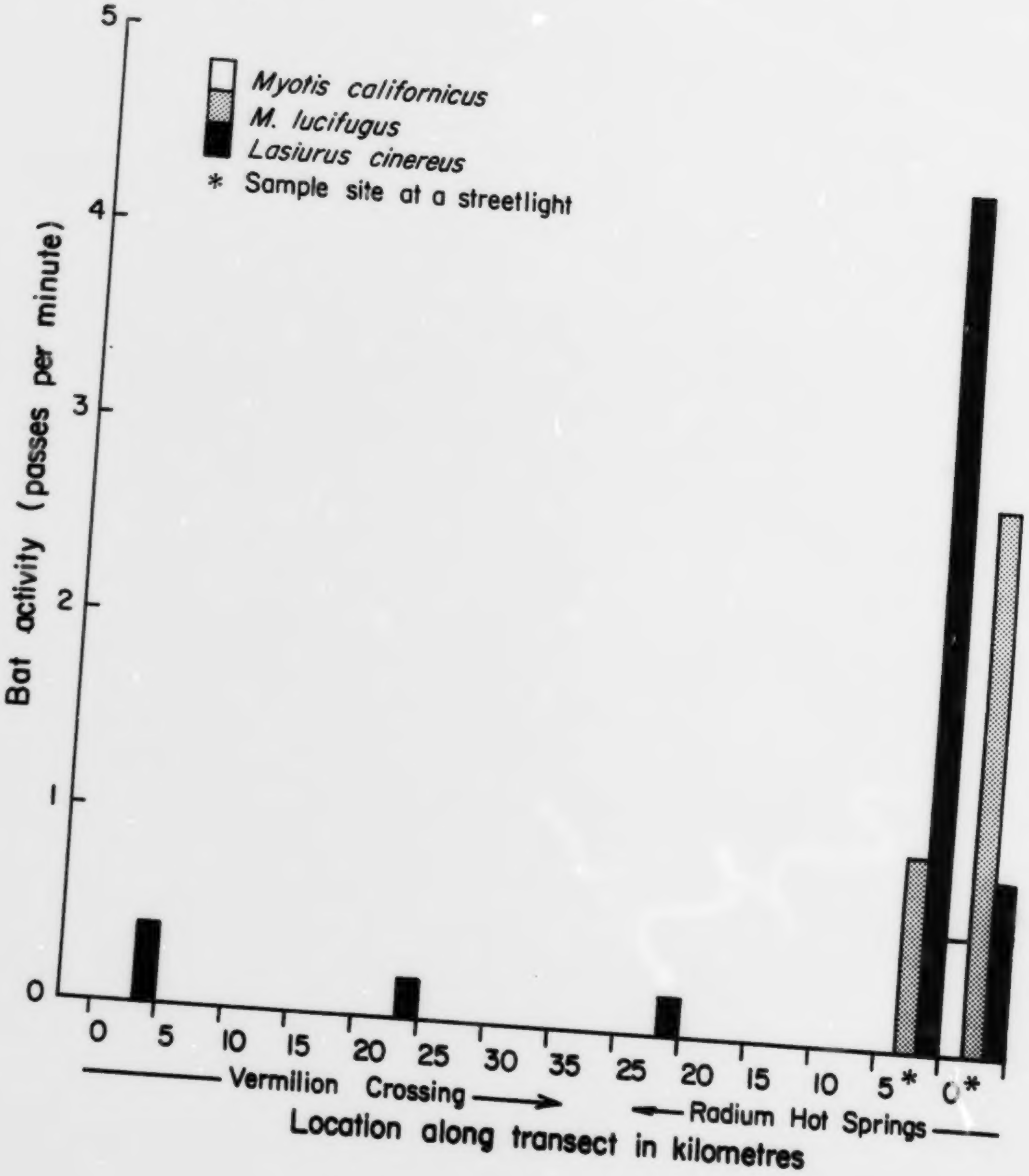
Big brown bats inhabit forested areas and buildings in both rural and urban areas. In KNP, they were found in the lowest elevation Montane forests adjacent to the Columbia valley. KNP appears to contain marginal habitat for this species. All of the big brown bat echolocations were at street lights - none were encountered on the road transects adjacent to undisturbed forest. They are likely dependant on human development for roost sites and feeding sites in this area.

SPECIES ATTRIBUTES

Big brown bats feed on flying insects including beetles, flying ants, flies, stoneflies and other insects (Phillips 1966). They emerge at dusk and forage high over forests and meadows with a characteristically straight, swift flight pattern.

The timing of arrival and departure in KNP is unknown. The big brown bat shows greater tolerance to cold than other bats in Canada. It is typically active later in the fall and earlier in the spring than other species. Mating occurs in autumn but females do not ovulate until April. The single young is born between early June and mid-July (Schowalter and Gunson 1979).

Figure 4.1. Bat activity in five minute samples at five kilometre intervals along Highway 93, Kootenay National Park, 31 July 1981.



MANAGEMENT CONSIDERATIONS

The big brown bat appears to be dependant upon insects attracted by street lights in the lower Sinclair Cr. area. No roosts or colonies were found but there is likely at least one small colony in the lower Sinclair Cr. watershed. If a colony were found in a building it would likely represent the park's total population and should not be destroyed.

AMERICAN PIKA *Ochotona princeps* PIKA

STATUS AND DISTRIBUTION

The American pika occurs in the mountains of Alberta and southern B.C.

This species is common only in its high-elevation habitat in KNP. Munro and Cowan (1944) did not encounter the pika in KNP but only because they did not visit any high-elevation talus slopes. Fifteen new records were obtained from widespread localities during the inventory (Figure 4.2).

HABITAT

The American pika occurs from the Alpine down to the Lower Subalpine Ecoregion as low as 1500 m. at Marble Canyon (Park wildlife cards). The only upper limit on its distribution is linked to the availability of green vegetation for forage at high altitudes. The pika is most common in the Alpine and Upper Subalpine in rock slides, boulder piles or scree slopes adjacent to green vegetation. It occurs within a wide variety of open forest shrub or herbaceous vegetation types but open rock piles or scree slopes are the essential habitat component. These often occur at a scale too small to map at 1:50,000 but are most common in colluvial Ecosections in the Alpine (BS, RD, TK); in the Upper Subalpine (BP, EN, WF, WH); occasionally in the Lower Subalpine (FV, SB) and often in rocky miscellaneous landforms (T, CR, R, M).

SNOWSHOE HARE *Lepus americanus* SNHA

STATUS AND DISTRIBUTION

Snowshoe hares are widespread and common in northern mixed and boreal forests of Canada, including all of B.C. except for the north and offshore islands (Banfield 1974).

The hare is widespread and common in KNP. It is first mentioned in the 1934 warden report as increasing in the Sinclair District. Munro and Cowan (1944) observed hares occasionally from Radium to Marble Canyon but found it nowhere abundant. From 1951 to 1977, 24 hares were reported on 21 warden records. Sightings have occurred in the Tokumm, Upper Vermilion, upper and lower Kootenay (60%) and Sinclair (28%) watersheds. There were few records during this period from the north end of the park. However, during the Vermilion Pass burn study (1971 to 1977) hares were common both in the burn and in the nearby successional forest (Harris 1977).

The snowshoe hare, throughout much of its range, undergoes cyclical fluctuations in abundance with a six to 13 year periodicity. There is no direct evidence of cyclical fluctuations of hare populations in KNP, however, lynx records since 1951, although few in number, show an approximate nine year cycle of abundance. There was no clear pattern of increase in hare abundance in BNP and JNP between 1976 and 1980 to correspond to a peak in hare numbers elsewhere in western Canada during 1980 and 1981 (Holroyd and Van Tighem 1983) .

HABITAT

Snowshoe hares inhabit closed and open coniferous forests from the Montane to Upper Subalpine Ecoregion, however, they are most abundant at lower elevations (Table 4.3). Of the 20 highly important

Figure 4.2. American pika and hoary marmot distribution in KNP from park wildlife cards, 1978-1983.

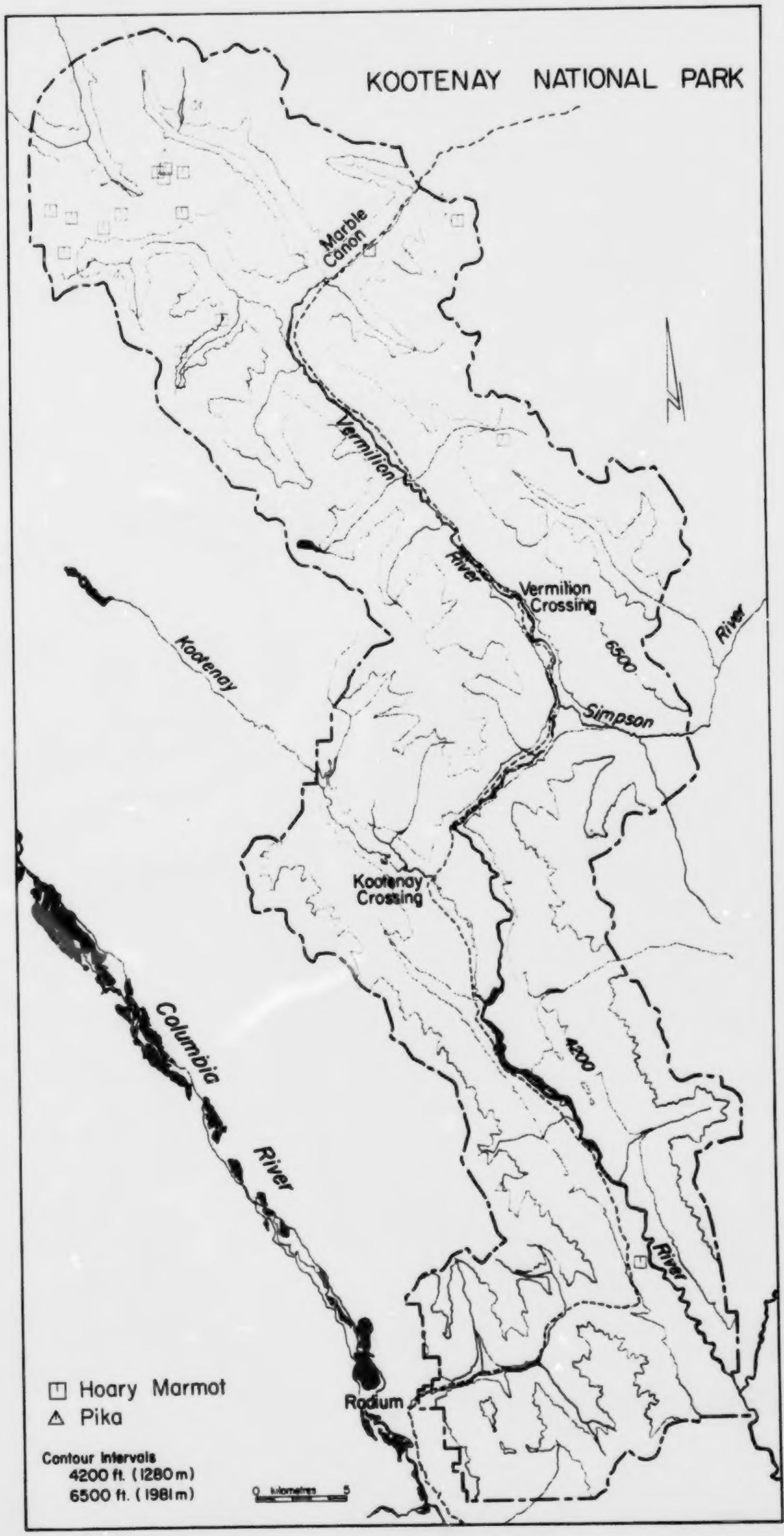

KOOTENAY NATIONAL PARK
Marble Canon
Vermilion
River
Vermilion Crossing
6500
River
Simpson
Kootenay
Kootenay Crossing
Columbia
River
4200
River
Radium
☐ Hoary Marmot
△ Pika
Contour intervals
4200 ft. (1280 m)
6500 ft. (1981 m)
0 kilometres 5

Table 4.3. Distribution of the snowshoe hare by Ecoregion.

Ecoregion	Mean pellet frequency (%)	Mean tracks per km-day
Montane	20.8	5.2
Lower Subalpine	25.4	2.2
Upper Subalpine	17.3	3.3
Alpine	0.0	n/a

Ecosites for hares, eight were Montane, five were Lower Subalpine and seven were Upper Subalpine (Table 4.4). The availability of cover is the major factor influencing hare habitat selection. Of the 12 highly important vegetation types for snowshoe hares, only three were not coniferous forests (Table 4.5).

SPECIES ATTRIBUTES

During summer, hares eat a variety of green grasses, forbs and leaves of deciduous shrubs. In the winter their diet consists almost exclusively of the buds, twigs and bark of woody plants as well as the buds and needles of conifers. During 1981 and 1982 a total of 11,865 shrubs (see section 2.2.6) were assessed for hare browsing. Hares showed a high preference for ***Acer glabrum*, *Betula glandulosa*, *Betula papyrifera*, *Cornus stolonifera*, *Ledum groenlandicum*, *Lonicera utahensis*** and ***Vaccinium myrtillus*** (Table 4.6). However, these species are generally of low occurrence and therefore, unlikely to provide the bulk of the consumed biomass. Shrub species with a higher abundance and moderate to high use by hares include: ***Shepherdia canadensis*, *Menziesia glabella*, *Vaccinium membranaceum*, *Vaccinium scoparium*, *Amelanchier alnifolia*, *Rhododendron albiflorum***, and ***Pseudotsuga menziesii*** (Table 4.6).

The breeding season for hares begins in mid-March and continues until September. Mature females have an average of 2.75 litters per year with as many as four. The mean litter size is four with a range of one to eight. No litter size data were collected during the inventory.

Snowshoe hares are prey items for a variety of carnivores, including the Great Gray Owl, Barred Owl, Red-tailed Hawk, Cooper's Hawk, Northern Goshawk, Canada lynx, bobcat, cougar, red fox, coyote, wolf, mink, fisher and marten.

LEAST CHIPMUNK *Eutamias minimus* LECH

STATUS AND DISTRIBUTION

The least chipmunk occurs throughout the boreal forests of western Canada.

Only two records were obtained during the inventory, one from the Vermilion Pass burn and one from Goodsir Pass. There were no previous records of this species in KNP although it is found commonly from the Montane to the Alpine in BNP (Holroyd and Van Tighem 1983) . In those parts of BNP adjacent to KNP, the least chipmunk is rare except in alpine and timberline areas. Similarly, the least chipmunk is rare in KNP.

HABITAT

The two specimens both came from the Subalpine Ecoregion as high as 2200 m. One was trapped in a subalpine larch-subalpine fir/heather (O13) open forest (BP2) and the other from the Vermilion Pass burn lodgepole pine/twinflower-fireweed (S5) shrubland (BY7). It may be expected to occur in other Alpine and Subalpine Ecosites at the northern end of KNP.

Table 4.4. Highly important Ecosites for snowshoe hares in KNP based on pellet group counts and winter track transects.

Ecosite	Pellet frequency (%)	Tracks/km-day	Ecoregion
BP2	1.3	6.7	Upper Subalpine
BY7	42.8	2.5	Lower Subalpine
CA2	66.4	-	Lower Subalpine
CA4	37.5	-	Lower Subalpine
DG1	50.0	-	Montane
DR1	33.0	5.3	Montane
DR2	18.1	40.0	Montane
DR5	26.3	22.3	Montane
DR8	3.3	13.5	Montane
EG1	40.8	6.0	Upper Subalpine
EG3	60.0	2.2	Upper Subalpine
EG4	-	6.8	Upper Subalpine
FR1	41.3	1.6	Montane
FV3	92.3	-	Lower Subalpine
SB3	48.0	-	Lower Subalpine
SX1	0.0	7.8	Upper Subalpine
VL6	6.7	5.7	Montane
WF5	43.0	-	Upper Subalpine
WH6	54.3	-	Upper Subalpine
WY1	85.0	32.7	Montane

Table 4.5. Highly important vegetation types for snowshoe hares from pellet group counts and winter track transects.

Vegetation type	Pellet frequency (%)	Tracks per km-day	Description
C1	60.0	28.7	Douglas fir/hairy wild rye
C5	40.0	3.7	white spruce-Douglas fir/feathermoss
C11	71.3	12.1	lodgepole pine-spruce/feathermoss
C15	52.6	-	Engelmann spruce-subalpine fir/grouseberry
C18	50.0	-	lodgepole pine/buffaloberry/grouseberry
C19	55.0	6.4	lodgepole pine/buffaloberry/twinflower
C20	35.3	2.6	lodgepole pine/false azalea/grouseberry
C25	35.0	-	Engelmann spruce-subalpine fir/tall bilberry
C39	30.0	6.4	lodgepole pine/buffaloberry/bunchberry
O4	27.8	1.6	Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine
O13	2.3	9.1	subalpine larch-subalpine fir/heather
O17	-	4.7	white spruce/juniper/bearberry

Table 4.6. Forage selection of the snowshoe hare by Ecoregion based on browse use transects.

Forage species	Frequency (%)	Percent use by hares	Electivity Index*
Montane			
Salix scouleriana	0.04	15.8	+0.99
Vaccinium myrtillus	0.05	4.3	+0.98
Betula papyrifera	0.5	4.0	+0.98
Betula glandulosa	0.8	2.7	+0.94
Cornus stolonifera	0.9	2.2	+0.92
Lonicera involucrata	1.5	13.7	+0.80
Acer glabrum	3.0	21.2	+0.75
Vaccinium scoparium	1.4	10.0	+0.75
Lonicera involucrata	2.7	14.0	+0.68
Pseudotsuga menziesii	3.1	11.4	+0.58
Salix spp.	2.4	7.0	+0.50
Shepherdia canadensis	11.2	18.9	+0.50
Amelanchier alnifolia	5.7	9.4	+0.25
Menziesia glabella	1.5	1.3	-0.08
Picea glauca	2.9	2.1	-0.15
Rosa acicularis	20.4	7.5	-0.46
Spiraea lucida	14.6	5.3	-0.47
Populus tremuloides	1.2	2.8	-0.59
Lower Subalpine			
Ledum groenlandicum	0.8	11.4	+0.99
Lonicera involucrata	0.6	20.0	+0.99
Vaccinium myrtillus	0.9	25.0	+0.99
Betula glandulosa	0.5	9.5	+0.99
Acer glabrum	0.7	9.4	+0.98
Alnus crispa	1.7	15.9	+0.81
Pinus contorta	1.3	7.5	+0.80
Spiraea alba	2.5	21.4	+0.79
Rhododendron albiflorum	4.1	18.0	+0.63
Salix spp.	2.2	7.7	+0.56
Vaccinium membranaceum	7.0	25.0	+0.56
Populus tremuloides	1.2	3.9	+0.52
Shepherdia canadensis	6.4	18.9	+0.50
Vaccinium scoparium	9.0	19.8	+0.38
Amelanchier alnifolia	1.9	3.8	+0.33
Menziesia glabella	14.7	23.0	+0.22
Upper Subalpine			
Spiraea lucida	0.1	3.6	+0.97
Menziesia glabella	1.8	38.0	+0.91
Vaccinium myrtillus	1.8	24.0	+0.86
Picea engelmannii	1.4	10.8	+0.78
Vaccinium membranaceum	6.0	23.2	+0.59
Rhododendron albiflorum	8.7	26.4	+0.50
Salix spp.	7.0	5.8	-0.09

*Electivity Index after Trottier *et al.* (1983) ranges from +1 (preference) to -1 (avoidance): (% species browsed - % species in stand)/ (% species browsed + % species in stand)

YELLOW-PINE CHIPMUNK *Eutamias amoenus* YECH

STATUS AND DISTRIBUTION

The yellow-pine chipmunk occurs commonly in the mountains of south-central B.C. and southwestern Alberta.

The yellow-pine chipmunk is widespread but uncommon in KNP. Munro and Cowan (1944) recorded it as uncommon. However, in the area of the Vermilion Pass burn it is common (see Harris 1976). During the inventory, nine were captured (0.9% of all captures) on 6 of the 50 snap-trap lines. The highest density found was 1.7 captures per 100 trap nights in late August (Ecosite: DR8; v.t.: H11). The highest average density found was 0.4 captures per 100 trap nights in SMA 4.

HABITAT

The yellow-pine chipmunk is found in the Montane and Lower Subalpine Ecoregions as high as 1650 m. Most records are from DG3, VL2, DR3, PP3 and BY7. They are commonest in open habitats including open douglas-fir forests (O5), dry lodgepole pine/twinflower-fireweed (S5) burns, hairy wild rye-wild strawberry-fireweed (H5) avalanche meadows, water sedge-beaked sedge (H11) fens and, occasionally, lodgepole pine/Labrador tea (C29) forests.

SPECIES ATTRIBUTES

The yellow-pine chipmunk is the common chipmunk in KNP but at high elevations (particularly in the northern part of the park) the least chipmunk may also be found; care should be taken when visually indentifying chipmunks.

HOARY MARMOT *Marmota caligata* HOMA

STATUS AND DISTRIBUTION

Hoary marmots occur at high elevations in the mountains of western Canada, Alaska and the northwestern U.S.A. (Lee and Funderburg 1981).

Hoary marmots are widespread but common only in their specialized habitat in KNP. Undoubtedly marmots were present in the park historically but there are few records. Munro saw one by the road at the BNP-KNP boundary in 1926 (Munro and Cowan 1944). They also reported two marmots by the road side at Sinclair Summit. There were ten observations of a total of twelve hoary marmots between 1951 and 1980 (park wildlife cards). There were 3 observations from the upper Vermilion watershed, 2 from the lower Kootenay, 2 from the Sinclair, and one from the lower Vermilion. During the wildlife inventory there were 23 records of hoary marmots, 12 from the Ochre, 7 from the upper Ottertail, 3 from the upper Vermilion and one from the lower Kootenay watersheds. Hoary marmots are most frequently observed in the Goodsir Pass, upper Helmet Cr., Ottertail Pass, Vermilion Pass, Mt. Stanley, Mt. Kindersly and Mt. Sinclair areas (Figure 4.2).

HABITAT

Hoary marmots occur from the Montane to the Alpine but are most common in the Alpine and Upper Subalpine Ecoregions. They are found on colluvial and morainal landforms with Engelmann spruce-subalpine fir/heather (O10) and subalpine larch-subalpine fir/heather (O13) open forests and heath and tundra vegetation. Ecosites in which hoary marmots were recorded most commonly include: BP2, EG4 and SX2 in the Upper Subalpine and RD2 and talus slopes in the Alpine. Hoary marmots are loosely-colonial, living in dens in rock slides, loose talus or under large boulders in open, hilly areas which afford defense from predators.

SPECIES ATTRIBUTES

Whistling upon the approach of predators or large animals is a communal defense mechanism. Marmots hibernate for eight months of the year living on stored fat. In summer they forage on forbs, grasses, sedges, mosses and willows.

WOODCHUCK *Marmota monax* WOOD

STATUS AND DISTRIBUTION

The woodchuck is widespread in Canada and is found in the southern interior and northern and central B.C. as far east as the Purcell Mountains.

There are three records of this species in KNP. One was seen by a campground attendant near McLeod Meadows in 1976 (John Nairn, pers. comm.). Warden J. Taylor (pers. comm.) reported a woodchuck at Kootenay Crossing Warden Station in the late 1970's. A pair was seen by Canadian Wildlife Service staff along the highway one km. north of Dolly Varden picnic site in July 1983. The pair was not found subsequently.

HABITAT

All observations of woodchucks in KNP were from disturbed sites in Montane lodgepole pine forest. Woodchucks usually inhabit open parkland forest or the edges of fields, but are also found in alpine rock-slides (Cowan and Guiguet 1965).

COLUMBIAN GROUND SQUIRREL *Spermophilus columbianus* COSQ

STATUS AND DISTRIBUTION

The Columbian ground squirrel occurs in the Rocky Mountains of Alberta and B.C. and in the Columbia and southern Cascade Mountains of B.C.

This ground squirrel is abundant and widespread in KNP, occurring at all elevations. Munro and Cowan (1944) considered this species abundant south of Vermilion Crossing in KNP (Figure 4.3).

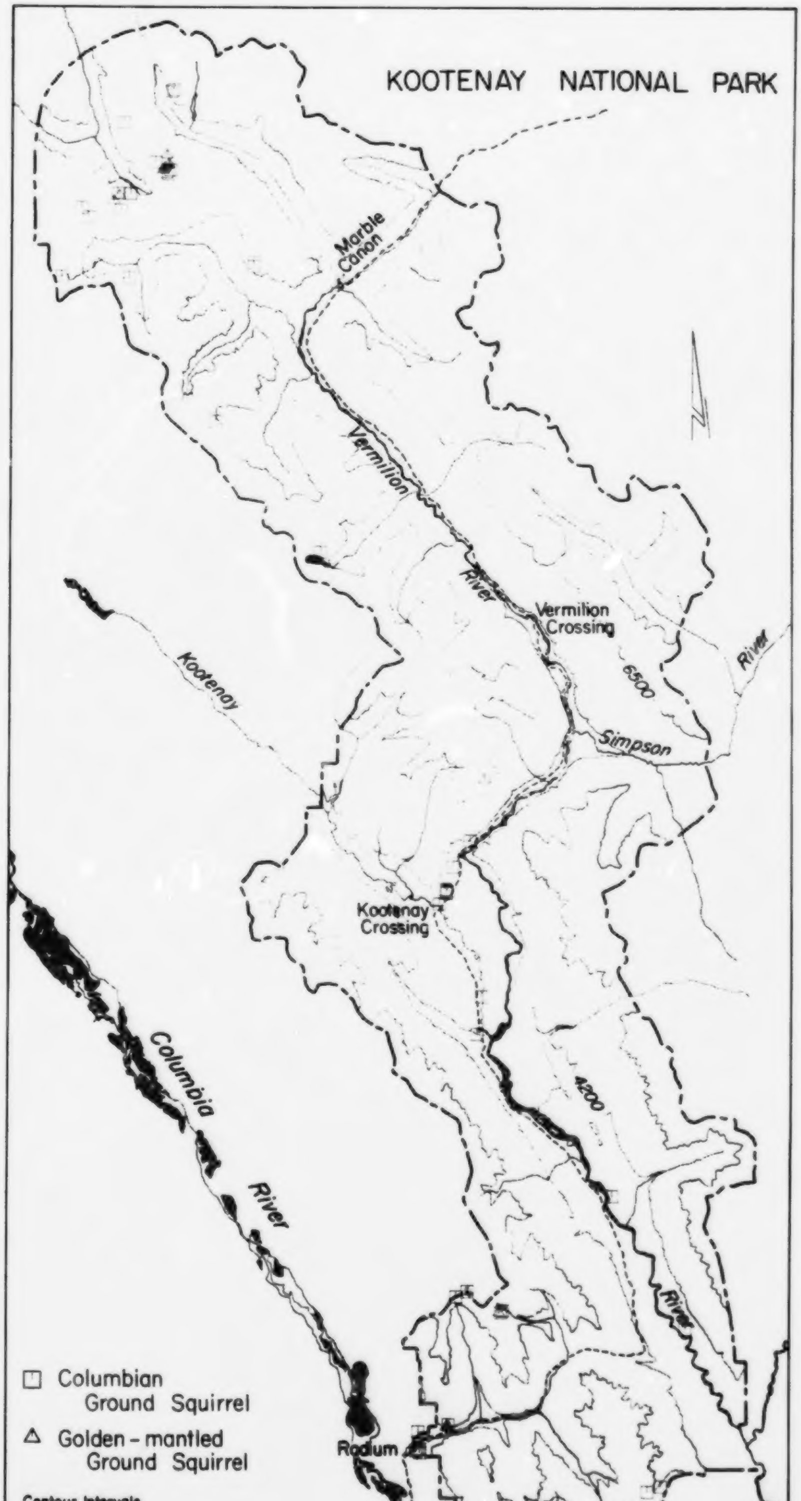
HABITAT

The Columbian ground squirrel is found in all Ecoregions, from the lowest elevations in the Montane at Radium up to the alpine meadows of the Alpine Ecoregion (highest record is 2470 m.). Columbian ground squirrels are found wherever there is a well-developed herbaceous layer for forage and friable soil for burrowing. Munro and Cowan (1944) considered them abundant in burns and dry, open places. They are abundant in alpine and subalpine mountain avens-snow willow-moss campion (H1), fleabane-valerian (H16) and heather-everlasting (L5) meadows, and open Engelmann spruce-subalpine fir/heather (O10), subalpine larch-subalpine fir/heather (O13) and Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine (O4) forests at treeline. They are also abundant in low elevation Douglas fir/juniper/bearberry (O5) forests and in disturbed areas such as on the lawns around buildings and grassy roadsides throughout the park.

SPECIES ATTRIBUTES

The Columbian ground squirrel is an important prey item for predators in the summer months. It hibernates from September to April and can emerge from hibernation while there is still snow on the ground at high elevations. At Radium, the earliest emergence date varies annually from 4 April to 16 April and they enter hibernation in mid to late August (naturalist files).

Figure 4.3. Columbian ground squirrel and golden-mantled ground squirrel distribution in KNP from park wildlife cards, 1978-1983.


KOOTENAY NATIONAL PARK
Marble Canon
Vermilion
River
Vermilion Crossing
6500
River
Simpson
Kootenay
Kootenay Crossing
Columbia
River
4200
River
Radium
☐ Columbian Ground Squirrel
△ Golden-mantled Ground Squirrel
Contour Intervals
4200 ft. (1280 m)
6500 ft. (1981 m)
0 kilometres 5

GOLDEN-MANTLED GROUND SQUIRREL *Spermophilus lateralis* GOSQ

STATUS AND DISTRIBUTION

The golden-mantled ground squirrel is restricted to the mountains of southwestern Alberta and the Rocky and Columbia Mountains of southeastern B.C.

The golden-mantled ground squirrel is uncommon but widespread in KNP (Figure 4.3). Munro and Cowan (1944) reported golden-mantled ground squirrels from Marble Canyon, a burn 2 miles south of Vermilion Crossing, Sinclair Summit and Radium Hot Springs. During the inventory the colonies at Marble Canyon and Radium Hot Springs were found to be still thriving and records were obtained from eight other widely scattered high-elevation locations in KNP.

HABITAT

The golden-mantled ground squirrel is found from the Alpine down to the Montane Ecoregion, from very high elevations (highest record is 2620 m.) to the lowest elevations at Radium Hot Springs. (1000 m.). This species prefers rough, rocky or broken ground, being most common in colluvial Ecosections in the Alpine and Subalpine (RD, WF, WH, SB) although it can be found in any rocky area.

RED SQUIRREL *Tamiasciurus hudsonicus* RESQ

STATUS AND DISTRIBUTION

The red squirrel is widespread and abundant in forested regions across Canada and throughout B.C.

The red squirrel is widespread and abundant in KNP. A total of 885 red squirrel tracks was counted in 315.4 km-days of winter tracking (average 2.806 tracks per km-day). Munro and Cowan (1944) rarely heard or saw red squirrels but found abundant workings and burrows.

HABITAT

Red squirrels are most common in the Montane Ecoregion (4.27 tracks per km-day) and less common in the Lower Subalpine (1.03 tracks per km-day) and Upper Subalpine (0.74 tracks per km-day). High densities of red squirrels were found in closed lodgepole pine forests of all types, lodgepole pine/spruce (C36) forests, Douglas fir (C1) forests, spruce/Douglas fir (C5) forests and open spruce (O3, O17) forests. They occur at medium densities in open Douglas fir (O5) forests, open whitebark pine (O4) forests, open spruce/subalpine fir (O6) forests, wet spruce (O11) forests, closed mixed forests (C44) and closed spruce (C37, C41) forests. The highest densities found were 10.00 tracks/km-day in white spruce/juniper/bearberry (O17) forests and 9.23 tracks/km-day in lodgepole pine/juniper/bearberry (C3) forests.

For abundance rankings in the Wildlife Legend of the Map Supplement and Ecosite accounts in Volume 1, a relative density of more than 3.2 tracks per km-day was considered high; between 1.72 and 3.2, medium and less than 1.72, low.

SPECIES ATTRIBUTES

The principal foods of the red squirrel are conifer seeds, fungi and the growing shoot tips of conifers in summer. The red squirrel is active all year and an important winter food source for raptors and marten.

NORTHERN FLYING SQUIRREL *Glaucomys sabrinus* FLSQ

STATUS AND DISTRIBUTION

The northern flying squirrel is widespread but uncommon in forested regions in Canada and is found throughout mainland B.C.

The northern flying squirrel is uncommon but widespread in KNP. Munro and Cowan (1944) trapped a female flying squirrel at Vermilion Crossing in June 1943. This species was frequently taken in marten traps, prior to 1920, in what is now the park. During the Vermilion Burn studies (Harris 1977), northern flying squirrels were occasionally seen in lodgepole pine successional forests. They have been observed at Kootenay Crossing and in Sinclair Canyon, just west of John McKay Cr. (Park wildlife cards). One flying squirrel was caught at Sinclair Cr. trail at 1520 m.on one of the 50 snap trap lines set out during the inventory.

HABITAT

Northern flying squirrels probably occur in most forests in KNP, provided there are suitable nest sites. Winter nests are in hollow trees but summer nests may also be constructed of twigs and branches in limbs. This squirrel is nocturnal and not readily observed so there are few records. Most records of the northern flying squirrel are from the Montane Ecoregion (AT, DG, DR Ecosections) although some are from the Lower Subalpine (BY Ecosection). The northern flying squirrel has been found in lodgepole pine forests, Douglas fir forests and spruce forests in KNP.

BEAVER *Castor canadensis* BEAV

STATUS AND DISTRIBUTION

Beavers are widespread and common across Canada south of the arctic. In B.C. numbers were depleted by the early part of the century through over harvesting but have increased and expanded since then as a result of harvest regulation. The current B.C. population is estimated at 400,000 to 600,000 of which approximately 6% are in the Kootenay Region (Munro and Fyfe 1979).

In KNP beavers are uncommon and restricted in distribution. Although beavers were present when the park was formed there are only three references to them prior to 1943. In October 1921 "a lot" of beaver sign was reported on Mud Cr. In 1932, beaver were considered more plentiful in the northern portion of the park than in previous years. During the summer of 1943 Munro and Cowan (1944) found several beaver colonies along Dolly Varden Cr. and beaver workings along the Kootenay River. There were an estimated 20 beaver in the park in 1944 (park files). There were no records to suggest that beavers were decreasing in the park during the late-1940's and early-1950's, however, Warden Thompson transplanted one pair to Dog Lake and one pair to Dolly Varden Cr. in September 1952. Both pair were reported doing well in July 1953.

There are 17 warden records of beaver from 1957 to 1983. Areas where beaver have been reported are:

Upper Kootenay River: Fresh cutting by beavers were observed at the junction of the upper Kootenay and White-tail Cr. in November, 1975. Beaver are still active along the upper Kootenay at the present time.

Dolly Varden Cr.: Beaver activity in this area was recorded in 1973, 1975, 1976 and 1981. Warden Downing conducted two ground surveys for beaver along this creek during July 1976. He found two areas of beaver activity, one about one km. north of the Dolly Varden fire road bridge, the other approximately 900 m. south of the bridge. In both areas sign of recent repair work on dams was evident, however no beavers were seen during the surveys. This creek is one of the most important areas for beavers in the park but at present there are only a few active lodges along this drainage.

Meadow Cr.: Fresh beaver sign was observed at Meadow Cr. in October, 1975.

Dog Lake: Most recorded beaver sightings have occurred at Dog Lake, with nine observations between 1951 to 1956. Fresh beaver sign was recorded in April, 1968 and recent beaver workings were noted in August 1975. There was one active lodge on the lake during 1981 and 1982 and a second lodge in 1983.

Settler's Pond: This is a small pond about 2 km. north of the Settler's road turn-off. In October 1980 there was fresh sign of a beaver working on a dam and lodge in this area.

Vermilion River: In December 1979 fresh cutting of poplar, willow and birch was noted along the Vermilion River near Mt. Wardle. This was the first recorded beaver activity in the Vermilion River. Warden B. Irons observed a beaver using a bank burrow in this same area in January 1983.

Kimpton Cr.: There are two observations from this creek, which constitute the only records of beaver in the Sinclair watershed. A beaver was seen along the creek by warden Boyle in October 1953 and a dam was seen in April 1955.

HABITAT

In KNP beavers are found only along Montane rivers, streams and lakeshores in association with deciduous growth, usually poplar and willow. The availability of such habitats is restricted in the park.

SPECIES ATTRIBUTES

Beavers feed on the leaves, twigs, buds and cambium of deciduous trees and shrubs, as well as aquatic vegetation. Food is cached at lodges for winter use. Favoured foods include aspen, willow, paper and dwarf birch and balsam poplar. Beaver were observed feeding on the cambium of young Douglas fir at Dog Lake in the spring of 1982, probably due to the scarcity of deciduous growth in this area. Food supply is a major factor in the location of new colonies: about 0.4 ha. of aspen forest will support a beaver for one year (Banfield 1974).

Flooding by beavers provides habitat for migrating and breeding waterfowl and amphibians. Standing dead trees in beaver pond areas are used by hole-nesting birds. Old dam sites provide sedge meadows which are important to meadow voles as well as foraging ungulates.

MANAGEMENT CONSIDERATIONS

The beaver is not plentiful in KNP. There is little conflict in the park between beavers and human activities. The maintenance of beaver populations is important because they provide habitat for other wildlife species. Being visible and having a unique ecology, they are of interpretive interest. Care should be taken in development planning to avoid areas where beaver are established. Any increase of deciduous growth along streams or around wetlands will benefit this species.

DEER MOUSE *Peromyscus maniculatus* DEMO

STATUS AND DISTRIBUTION

Deer mice occur commonly throughout Canada and B.C.

In KNP the deer mouse is widespread and common. Munro and Cowan (1944) caught very few (8) deer mice and considered that to be far below their normal population numbers. They were found to be abundant at the Vermilion Pass burn (see Harris 1976). During the inventory, deer mice were the second most commonly snap-trapped small mammal: 106 were snap trapped (11% of all captures) on 21 of the 50 snap trap lines. It was common on the Redstreak live-trap plot (maximum density of 24.8 per ha. in 1981). The highest density sampled by snap trapping was 10.4 captures per 100 trap nights (Ecosite: WY2; v.t.: O5) in late August. The highest average density sampled in any Small Mammal Association was 4.4 captures per 100 trap nights in SMA 1.

HABITAT

Deer mice are most common in the Montane, followed by the Lower Subalpine; none were captured during the inventory in the Upper Subalpine Ecoregion. Highest recorded elevation was 1650 m.; although they may occur in the Alpine (Guy 1975).

This species frequents a variety of open or semi-open habitats, as well as most disturbed sites. Highest densities (4.7 captures per 100 trap nights) were on AT1, DR2, WY2 and DG3 in aspen (C16, C22) and Douglas fir open (O5, O24) forests. A density of 3.5 captures per 100 trap nights was recorded on WY2 in junegrass-pasture sage-wild blue flax (H6) grassland.

Moderate densities were on DR1, DG1 and AT4, in Douglas fir/hairy wild rye (C1) forest and spruce-aspen-lodgepole pine (paper birch)/buffaloberry/pine grass (C44) forest. The density of deer mice on the Vermilion Pass burn (1.8 captures per 100 trap nights) in 1981 was lower than that recorded by Harris (1976).

SPECIES ATTRIBUTES

The deer mouse never reaches very high densities because young probably do not mature and reproduce in the summer of birth even in the Montane Ecoregion (see Millar and Innes 1982).

BUSHY-TAILED WOOD RAT *Neotoma cinerea* BURA

STATUS AND DISTRIBUTION

In Canada the bushy-tailed wood rat occurs in the mountains of B.C., southern Yukon Territory and western Alberta.

The bushy-tailed wood rat is uncommon but widespread in KNP. There are no warden records of wood rats but this species is a common invader of park facilities, particularly those used only seasonally. Munro and Cowan (1944) state that the bushy-tailed wood rat is "said to be much in evidence during autumn when the dispersal of young is in progress. At that time and in winter it is attracted to the cabins." They examined one specimen taken by Warden Meredith at Radium in June 1943. Seel (1965a) lists four specimens of bushy-tailed wood rat in the park collection; all taken in 1965: three from Redstreak campground and one from Radium junction. During the inventory there was only one observation of bushy-tailed wood rat sign in natural habitat: droppings were observed in a cave on upper Geddes Cr. on the west slopes of Mt. Berland in July 1982. Woodrats inhabited several trailers at the Conservation Corps camp in 1981 and 1982 and CWS staff assisted in livetrapping a wood rat at the John McKay Cr. staff residence in August 1983. It is probable, because of their nocturnal habits and the fact that sightings tend to go unrecorded, that wood rats are more common in the park than records indicate.

HABITAT

Wood rats inhabit cliffs, rock talus, caves, river canyons and rock outcrops in open Douglas fir, ponderosa pine, and Engelmann spruce-subalpine fir forests from the Montane to the Upper Subalpine Ecoregions. As previously mentioned it also finds abandoned buildings attractive.

SPECIES ATTRIBUTES

The wood rat is essentially nocturnal, solitary (except during the March to June breeding season) and remains active all winter relying on stored food for sustenance. Nests are built in buildings, caves, abandoned mine shafts, under cliffs or in rock crevices. One or two litters are produced each year with an average size of 3.5 and a range of one to six (Banfield 1974).

NORTHERN BOG LEMMING *Synaptomys borealis* NOLE

STATUS AND DISTRIBUTION

The northern bog lemming occurs sparsely throughout the boreal forests of Canada and mainland B.C.

The northern bog lemming occurs in widespread localities but is rare in KNP. Prior to the inventory, there was only one record of the northern bog lemming in KNP from the Vermilion Burn (Guy 1975). During the inventory this species was the least common mouse or vole: only 4 were captured (0.4% of all captures) on 3 of the 50 snap-trap lines. The highest density found was 1.1 captures per 100 trap nights in mid-October.(Ecosite: DR3; v.t.: S1). The highest average density was 0.1 captures per 100 trap nights in SMA's 1 and 4.

HABITAT

Northern bog lemmings prefer sedge meadows and bogs surrounded by, or near, spruce or subalpine-fir forest. In KNP it is found in both the Montane and Lower Subalpine as high as 1620 m. It is found in alluvial habitats (HD3, VL6) in white spruce-Douglas fir/feathermoss (C5) and Engelmann spruce-subalpine fir/false azalea (C14) forests, and in the wet dwarf birch-shrubby cinquefoil-willow/brown moss (S1) shrublands around Cobb Lake (DR3).

SPECIES ATTRIBUTES

At Cobb Lake the northern bog lemming is found in the same wet marsh-shrub habitat as the meadow vole indicating some overlap in the micro-distribution of these two voles whereas in GNP, they were never found together in the same habitat (Van Tighem and Gyug 1984).

HEATHER VOLE *Phenacomys intermedius* HEVO

STATUS AND DISTRIBUTION

The heather vole is widespread but uncommon throughout the boreal and mountain regions of Canada.

The heather vole is uncommon but widespread in KNP. Munro and Cowan (1944) caught four heather voles at two locations near Vermilion Crossing. Trottier *et al.* (1977) caught four heather voles near McLeod Meadows. Interestingly, none of the studies of the Vermilion Pass burn recorded heather voles (see Harris 1976). During the inventory, thirteen (1.4% of all captures) were snap trapped on 6 of the 50 snap-trap lines. The highest density found was 3.5 captures per 100 trap nights in mid-August (Ecosite: EG3; v.t.: O9). The highest average density was 1.3 captures per 100 trap nights in SMA 6.

HABITAT

The heather vole is most common in the Upper Subalpine as high as 2010 m. followed by the Lower Subalpine; it is least common in the Montane Ecoregion. The characteristic habitat of this species is difficult to classify as it has been found in virtually all habitats (Cowan and Guiguet 1965). In KNP it occurs in a wide array of habitats including glacial till (BY5, BY7, EG3) and fluvial (FR1, HC1) landforms. Vegetation types in which it is commonly found include western red cedar/oval leaf blueberry (C42) forest, lodgepole pine/buffaloberry/bunchberry (C39) forest, Engelmann spruce-subalpine fir/feathermoss (C13) forest and Engelmann spruce-subalpine fir/valerian-fleabane (O9) open forest. It also occurs in willow-dwarf birch/fleabane (S4) and lodgepole pine/twinflower-fireweed (S5) shrubland.

GAPPER'S RED-BACKED VOLE *Clethrionomys gapperi* GAVO

STATUS AND DISTRIBUTION

The red-backed vole is widespread and abundant in Canada.

In KNP, the red-backed vole is widespread and abundant. Munro and Cowan (1944) considered the red-backed vole fairly common and it was the most common small mammal caught in forests near the Vermilion Burn (see Harris 1976). During the inventory the red-backed vole was by far the most abundant small mammal: 700 (73% of all captures) were snap trapped on 35 of the 50 snap-trap lines. It was abundant on the Verendrye Cr. live-trap plot, reaching a density of 52.9 per ha. The highest density sampled by snap trapping was 34.1 captures per 100 trap nights in early October (Ecosite: HC1; v.t.: C13). The highest average density sampled was 13.9 captures per 100 trap nights in SMA 3.

HABITAT

The red-backed vole is the commonest small mammal in all of the Ecoregions sampled but is most common in the Montane, followed by the Lower Subalpine and Upper Subalpine. The highest elevational record during the inventory was 2225 m. The red-backed vole reaches highest densities in the following ecosites: AT1, DG1, DR5, DR7, EG3, EG4, FR1, FR3, HC1, HD3, PL1, PP3, SX1 and SX2; and in the following vegetation types:

white spruce-Douglas fir/feathermoss (C5) forest
lodgepole pine/buffaloberry/showy aster (C6) forest
Engelmann spruce-subalpine fir/feathermoss (C13) forest
Engelmann spruce-subalpice fir/Labrador tea/crowberry (C30) forest
Engelmann spruce-subalpine fir/heather/feathermoss (C34) forest
white spruce/buffaloberry/feathermoss (C37) forest
lodgepole pine/buffaloberry/pine grass (C38) forest
lodgepole pine/buffaloberry/bunchberry (C39) forest
white spruce-western larch-Douglas fir/bunchberry (C45) forest
Engelmann spruce-subalpine fir/valerian-fleabane (O9) open forest
Engelmann spruce-subalpine fir/heather (O10) open forest

They are absent from, or occur only at low densities, in shrub and herb vegetation types and dry open forests.

MEADOW VOLE *Microtus pennsylvanicus* MEVO

STATUS AND DISTRIBUTION

The meadow vole is widespread and abundant across Canada. It is found throughout B.C. except within the coastal mountain ranges.

In KNP, this species is widespread and common, occurring occasionally at high densities. Munro and Cowan (1944) considered the meadow vole the most abundant of the small mammals in KNP but this may have reflected the early successional stage of the area near Kootenay Crossing where they did most of their collecting. The meadow vole is now the third most common small mammal, after Gapper's red-backed vole and deer mouse.

Guy (1975) indicated that the meadow vole was common in and near the Vermilion Burn but since he recorded no captures of the heather vole there may have been mistakes made in identification. During the inventory, 52 (5.4% of all captures) were captured on 14 of the 50 snap-trap lines. The highest density found was 7.3 captures per 100 trap nights in late-July (Ecosite: VL2; v.t.: S1). The highest average density was 2.2 captures per 100 trap nights in SMA 4.

HABITAT

The meadow vole is most common in the Montane Ecoregion but is also found in the Lower Subalpine as high as 1620 m. Munro and Cowan (1944) found the meadow vole in many wet and dry open habitats. They are most common in dry dwarf birch-shrubby cinquefoil-willow/brown moss (S1) meadows (2.7captures per 100 trap nights) and wet or dry water sedge-beaked sedge (H11), hairy wild rye-wild strawberry-fireweed (H5) and yellow dryad-willow herb (H8) meadows. They are also found in spruce/Labrador tea/ brown moss (O11) fens (CV1) and lodgepole pine/twinflower-fireweed (S5) burns (BY7). Ecosites where this species was recorded include: VL2, DR3,·DR8, DR3, HD6, CV1 and BY7 (burned).

LONG-TAILED VOLE *Microtus longicaudus* LOVO

STATUS AND DISTRIBUTION

The long-tailed vole occurs in the mountains of western Canada. It is found throughout mainland B.C. except the central Interior.

The long-tailed vole is widespread but only moderately common in KNP. Munro and Cowan (1944) captured five long-tailed voles in KNP and only 18 were recorded in the 1175 small mammals caught in the Vermilion Pass burn studies (Harris 1976). During the inventory, 29 (3.0% of all captures) were captured on 10 of the 50 snap trap lines. The highest density sampled was 4.3 captures per 100 trap nights in early-August (Ecosite: DR3; v.t.: H5). The highest average density was 3.2 captures per 100 trap nights in SMA 8.

HABITAT

The long-tailed vole is found in equal abundance in the Montane, Lower Subalpine and Upper Subalpine Ecoregions. The highest elevational record during the inventory was 2010 m. The long-tailed vole is usually associated with shrub habitats, both in KNP and elsewhere (see Van Tighem and Gyug 1984 and Van Horne 1982). It is most common in hairy wild rye-wild strawberry-fireweed (H5) slide path meadows, willow-dwarf birch/fleabane (S4) shrublands, aspen-dwarf birch/bearberry (S16) slide path and Engelmann spruce-subalpine fir/feathermoss (C13) forests with alder in the understory.

RICHARDSON'S WATER VOLE *Arvicola richardsoni* WAVO

STATUS AND DISTRIBUTION

Richardson's water vole is confined to the southern Cascade, Columbia and Rocky Mountains.

There are no records of this species from KNP although Seel (1965a) lists it on his provisional list of mammals of KNP. It may be expected in KNP in suitable habitats since it is found in adjacent BNP (Holroyd and Van Tighem 1983) . However most of the park was surveyed during the inventory and it must be very rare or not present.

MUSKRAT *Ondatra zibethicus* MUSK

STATUS AND DISTRIBUTION

The muskrat is widespread and abundant across Canada. It occurs throughout B.C. except in the central Coast Range. Except for very restricted areas, primarily the lower portions of major river valleys, muskrats are absent from BNP and JNP (Holroyd and Van Tighem 1983).

Although they are common in the wetlands of the neighbouring Columbia valley, it appears that muskrats have never become established in KNP. Munro and Cowan (1944) reported a sighting from Sinclair Cr. and observations of tracks from Dog Lake and a wetland along Dolly Varden Cr. The other three records of muskrat in the park are all from the Sinclair Cr. drainage: one was reported near Kay's cabin along Sinclair Cr. in August 1947; Seel (1965a) lists a specimen collected at Redstreak campground in September 1963; and a muskrat was killed on the highway in Sinclair Canyon in April 1982.

HABITAT

Muskrats require wetlands with stable to periodically fluctuating water levels and sedge, sedge-grass, bulrush or cattail shorelines as well as submerged vegetation. Water depths should be greater than 1.0 m.to prevent freezing to the bottom in winter but less than 3.5 m. to allow growth of submerged vegetation. What little suitable habitat there is for muskrats in KNP is found only in the Montane Ecoregion.

WESTERN JUMPING MOUSE *Zapus princeps* WEMO

STATUS AND DISTRIBUTION

The western jumping mouse is confined to the Great Plains, northern B.C., the Rocky and Columbia Mts. and the southern interior of B.C.

In KNP, this species is uncommon, 13 (1.3% of all captures) having been caught on 3 of the 21 snap trap lines set out before mid-September (after mid-September they enter hibernation). Munro and Cowan (1944) considered this species common, being trapped "regularly" in a variety of habitats. It was the fourth most common mouse caught in the studies in and near the Vermilion Pass burn (Harris 1976). The highest density sampled by snap trapping was 4.4 captures per 100 trap nights in early August (Ecosite: DR3; v.t.: H5-avalanche complex). The highest average density was 1.4 captures per 100 trap nights in SMA 8.

HABITAT

During the inventory the western jumping mouse was found most commonly in the Montane with only one record from the Upper Subalpine Ecoregion as high as 2010 m., although it may be more common in the Subalpine than records indicate. Most trapping there was done after they had entered hibernation. This species is most common in hairy wild rye-wild strawberry-fireweed (H5) avalanche complexes and willow-dwarf birch/fleabane (S4) shrublands but is found in a wide variety of habitats including lodgepole pine/twinflower-fireweed (S5) burn and mature spruce/subalpine fir forest adjacent to the Vermilion Pass burn (Harris 1976).

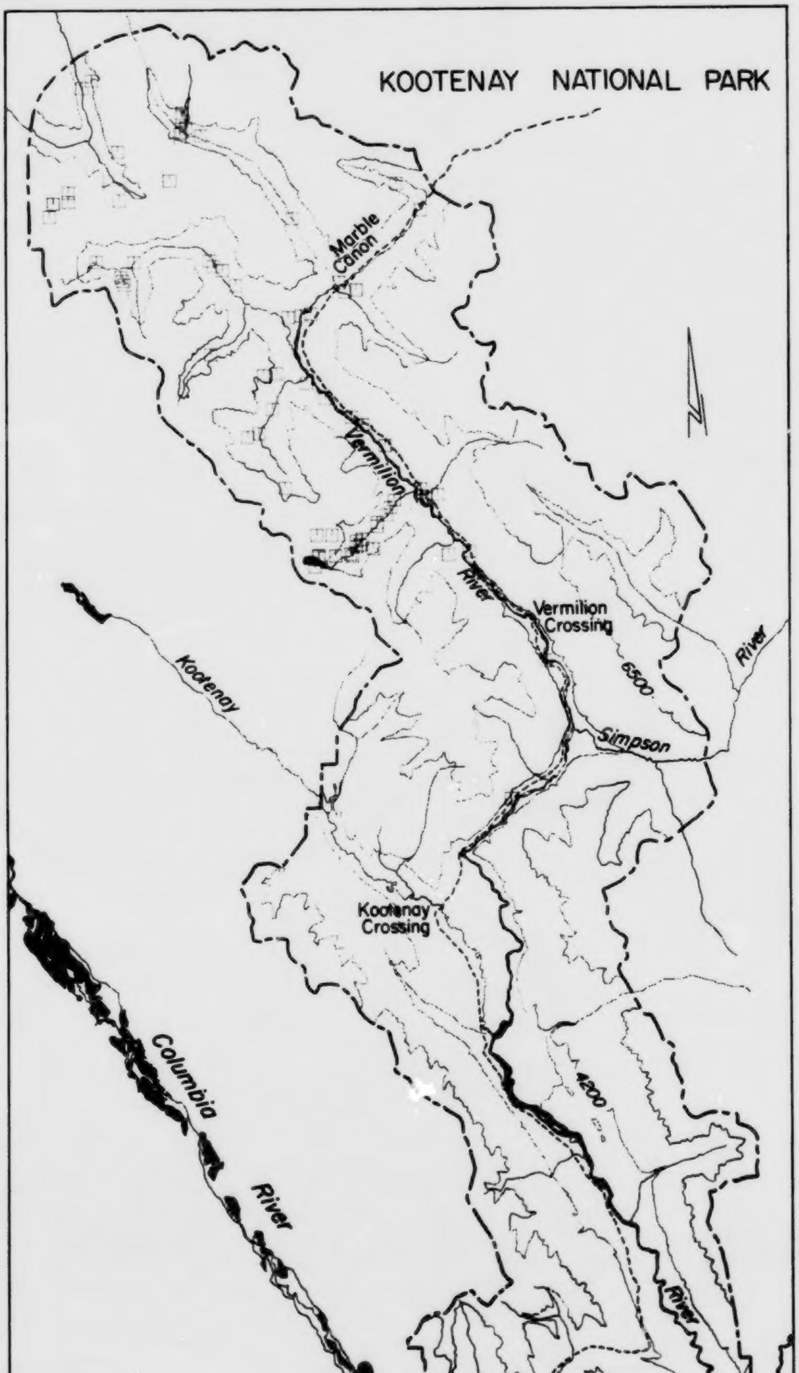
PORCUPINE *Erethizon dorsatum* PORC

STATUS AND DISTRIBUTION

The porcupine is widespread and common throughout Canada. In B.C. it is common throughout the mainland except in the Coast Range.

In KNP this species is common but restricted in distribution to the Main Ranges (Fig. 4.4). Of 78 park wildlife cards observations between 1951 and 1983 all but one were in Main Range watersheds: upper Vermilion (50% of observations), Ochre (29%), Tokumm (11.5%), Verdant (3.8%), upper Ottertail (2.5%) and lower Vermilion (2.5%). There are no records from the Simpson, Kootenay or Stoddart watersheds but one animal was killed on the highway at Sinclair Summit in September 1962. Porcupines were common in unburned pockets of spruce-fir and near the edges of the Vermilion Pass burn during the early 1970's (Harris 1976). During winter tracking studies porcupines were recorded primarily in the upper Vermilion and Ochre watersheds.

Figure 4.4. Porcupine distribution in KNP from park wildlife cards, 1978-1983.


KOOTENAY NATIONAL PARK
Marble Cañon
Vermilion
River
Vermilion Crossing
6500
River
Kootenay
Simpson
Kootenay Crossing
Columbia
River
4200
River
Radium
☐ Porcupine
Contour Intervals
4200 ft. (1280 m)
6500 ft. (1981 m)
0 kilometres 5

HABITAT

Porcupines are most common in the Lower and Upper Subalpine Ecoregions. They are recorded mostly on lower slopes and in valley bottoms. Ecosites on which they were recorded most frequently from random observations and winter tracking include: AL3(3), BP2(3), CA2(3), DR3(5), EG3(3), FV6(5), HC1(3), WH1(4) and WH6(2). Vegetation types most frequently used by porcupines include:

Engelmann spruce-subalpine fir/false azalea (C14) forest
Engelmann spruce-subalpine fir/grouseberry (C15) forest
Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) forest
Engelmann spruce-subalpine fir/rock willow/bracted lousewort (O14) open forest
subalpine larch-subalpine fir/grouseberry-everlasting (C23) forest
subalpine larch-subalpine fir/heather (O13) open forest
white spruce-Douglas fir/feathermoss (C5) forest

Other observations have been in lodgepole pine-spruce forest, avalanche meadows, and man-made grasslands.

SPECIES ATTRIBUTES

In summer, porcupines eat the leaves of a variety of forbs, shrubs and trees. During winter they feed on the inner bark and cambium as well as the buds and twigs of larch, subalpine fir, spruce and lodgepole pine. Porcupines gnaw bones, antlers and wooden structures, apparently to seek minerals.

Porcupines are primarily nocturnal and are active all winter. They lead a solitary life except during the October to December breeding season. Usually one and infrequently two young are born, between May and August. Porcupines are relatively long-lived (10 years or more) and mature sexually at about 2.5 years.

The major predators of porcupines are cougar, wolverines and fisher although coyotes, wolves and foxes will occasionally prey on porcupines as well. They can be an important prey item for carnivores, especially in winter when prey is scarce in deep snow areas.

MANAGEMENT CONSIDERATIONS

Porcupines damage park facilities, particularly in the backcountry. Because of this species' low reproductive rate and importance as a winter food item for carnivores such as wolverine, management actions should be directed away from destruction of problem porcupines and toward finding suitable alternative building materials. Existing structures can be partially protected by tin or fiberglass applied to exposed surfaces. Porcupines appear to have a particular affinity for plywood and particle board and these should not be used in backcountry structures unless they can be protected.

COYO

COYOTE *Canis latrans*

STATUS AND DISTRIBUTION

The coyote occurs throughout southern and northeastern Canada, but is most common in the northwest (Banfield 1974). Over the last 150 years it has steadily expanded its range northward to include the Mackenzie River delta, northern Yukon Territory and Alaska and eastward to central and southern Ontario and western Quebec.

Coyotes occur throughout B.C. with an estimated total population of 70,000 to 100,000 of which 15% occur in the Kootenay Region (Goodchild *et al.* 1980). Coyotes are common in the low valleys of BNP, JNP and YNP (McCrory and Blood 1978; Holroyd and Van Tighem 1983).

Coyotes are common in KNP, particularly in the Kootenay and Vermilion valleys. In winter they are most prevalent in the lower Vermilion, throughout the Kootenay valley and in the Sinclair and Stoddart Cr.

watersheds where snow depths are most favorable and prey and carrion most abundant. During spring and summer they are somewhat more widespread, moving into watersheds that are unsuitable in winter because of deep snow.

Coyotes were reported in the park during the 1920's, however there were no estimates of abundance. During the 1930's coyotes apparently were widespread and abundant. In 1933 there were an estimated 30 coyotes in the Kootenay District and a total of 19 were destroyed in the park. The relatively high coyote populations during this period, particularly in the Kootenay District, may have been due to increased prey abundance resulting from the abundance of fire-successional habitats. By the mid-1940's, however, coyote numbers had declined somewhat partly as a result of control measures but also in response to declining prey populations, particularly ungulates. From 1938 to 1941 there were several reports of "many" coyotes and in 1944 wardens estimated the park population at 25 animals. Munro and Cowan (1944) indicated there was a moderate summer population in the Kootenay valley in 1943, but felt most left the park in winter to follow deer to winter ranges in the Columbia and Kootenay valleys.

Monthly warden wildlife reports indicate coyotes were increasing through the late 1940's, however by the mid-1950's they were considered widespread but scarce (Banfield 1952, Tener 1953, Ward 1954, 1956). It appears, from the park wildlife cards, that coyotes were at their lowest numbers during the late 1950's and 1960's. The number of observations each year increased in the early 1970's and has remained relatively constant since then.

During 50 road surveys conducted between May 1981 and May 1982, there were only 8 observations of coyotes, all between Settler's Road and Wardle flats. Of the 471 warden records of coyote between June 1951 and May 1983, 60% were from the lower Kootenay valley. The remaining 40% (in descending order of abundance) were from the lower Vermilion, Sinclair, upper Vermilion and upper Kootenay watersheds. There are no records in the park wildlife cards of coyotes in any other KNP watersheds.

During the inventory, 183 coyote tracks were recorded in 315.4 km-days of winter track transects (0.58 tracks/km-day). Coyotes were most numerous in the Kootenay (3.1 tracks/km-day) watersheds with tracks also recorded in the upper Vermilion (0.7 tracks/km-day) and Ochre Cr. (0.3 tracks/km-day) watersheds.

The seasonal distribution of coyotes in the park follows closely the distribution of major prey species (Fig. 4.5). Although the Park wildlife cards are biased in favour of areas adjacent Highway 93. These areas in the lower Kootenay and lower Vermilion watersheds have the greatest amounts of grassland, herb-shrub meadow and mixed forest habitats favoured by major summer prey species such as Columbian ground squirrels and meadow voles. In winter the lower Kootenay, lower Vermilion and the Sinclair watersheds have major concentrations of elk, mule deer and bighorn sheep upon which coyotes rely heavily as prey and carrion.

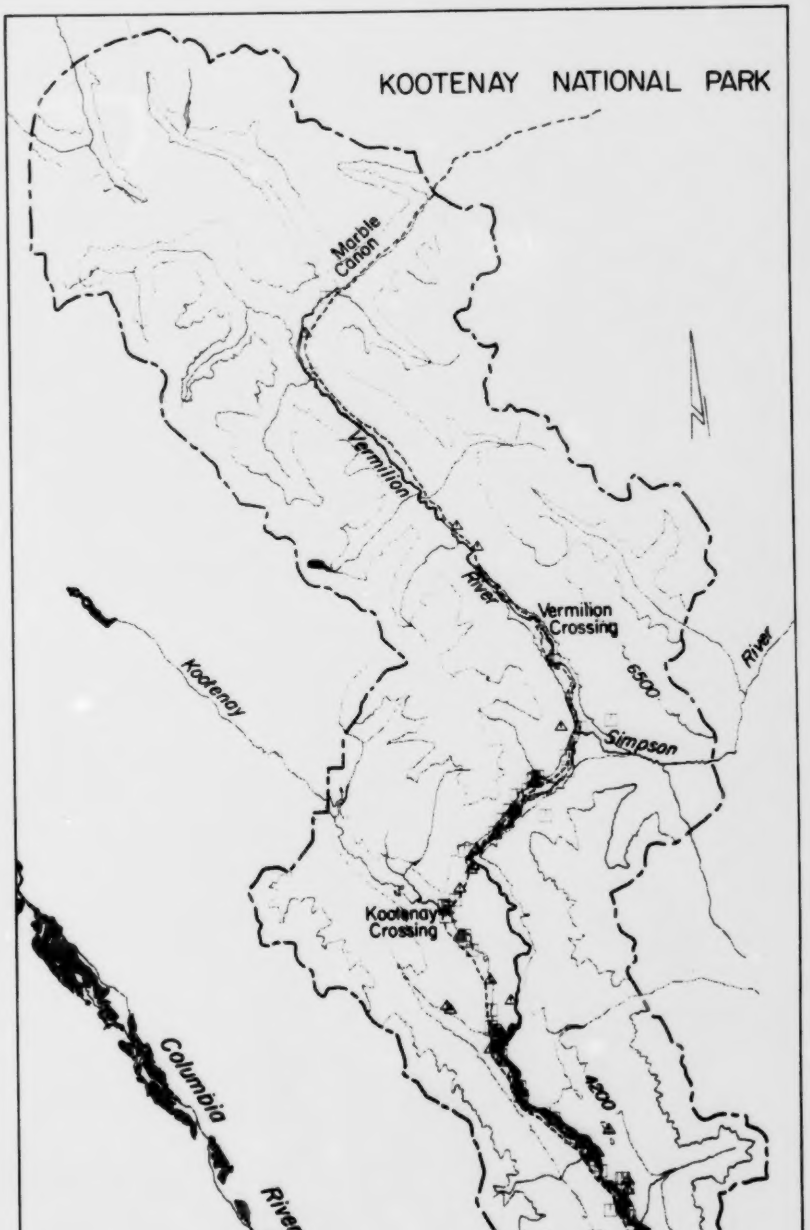
HABITAT

In KNP, coyotes are most abundant in Montane and Lower Subalpine valley bottoms, especially during winter. In winter, coyotes were most common in the Montane (0.32 tracks/km-day) followed by the Lower Subalpine (0.20 tracks/km-day) and the Upper Subalpine (0.06 tracks/km-day). There were no tracks or sightings of coyotes in the Alpine Ecoregion during the study, nor have there been any other records of coyotes in the Alpine since 1978 (park wildlife cards). Of the 126 park observations of coyotes from 1978 to 1983, 75% were from valley bottoms and 64% were between 1150 m. and 1220 m. Coyotes were observed from 914 to 1449 m. from warden records, but tracks were encountered in the Upper Subalpine at 2255 m. in March 1983.

The distribution of the coyote is dictated by food availability all year but in winter by snow depth as well because it impedes travel. Greatest track densities were recorded at snow depths less than 25 cm.,however tracks were encountered at snow depths up to 180 cm. during late winter when the snow pack was consolidated enough for easier travel. High ungulate concentrations in low elevation valley bottoms during winter provide coyotes with an abundant source of carrion from motor vehicle, predator and winter kills. Coyotes have also been observed to prey on mule deer, bighorn sheep, elk and mountain goats during winter (park wildlife cards).

In spring and summer, when snow no longer limits travel, coyotes extend their foraging into Lower Subalpine and Upper Subalpine open forests and herb-shrub meadows, but most remain at low elevations where major summer prey species such as Columbian ground squirrels and microtine rodents are most abundant. They

Figure 4.5. Seasonal coyote distribution in KNP from park wildlife cards, 1978-1983.


KOOTENAY NATIONAL PARK
Marble Canon
Vermilion
River
Vermilion Crossing
6500
River
Kootenay
Simpson
Kootenay Crossing
Columbia
River
4200
River
Radium
COYOTE
△ November to April
☐ May to October
Contour Intervals
4200 ft. (1280 m)
6500 ft. (1981 m)
0 kilometres 5

are attracted also to carrion dumping sites for road-killed ungulates i.e., 4-mile gravel pit, Hector Gorge fire road, Daer fire-tower road and Cross River fire road.

Important year-round Montane and Lower Subalpine vegetation types for coyotes based on winter tracking and prey availability are:

white spruce-subalpine fir/bunchberry-horsetail (C41)forest
Douglas fir/hairy wild rye (C1)forest
aspen/hairy wild rye-peavine (C16)forest
spruce-aspen-lodgepole pine (paper birch)/buffaloberry/pine grass (C44)forest
lodgepole pine/feathermoss (C11)forest
lodgepole pine/buffaloberry/pine grass (C38)forest
Engelmann spruce-subalpine fir/green alder (C25)forest
spruce/Labrador tea/brown moss (O11)open forest
white spruce/juniper/bearberry (O17)open forest
dwarf birch-shrubby cinquefoil-willow/brown moss (S1)shrub meadow
yellow dryad-willow herb (H8)meadow
water sedge-beaked sedge (H11)meadow

In addition to the above, heavy use is made by coyotes, year-round, of man-made grasslands along Highway 93 and disturbed lands at McLeod Meadows, Crook's Meadow, Dolly Varden Cr., and Kootenay Crossing.

SPECIES ATTRIBUTES

Coyotes survive on a variety of food items. Small to medium-sized mammals provide a year-round food source and in winter, ungulate carrion provides the bulk of the diet. During winter and spring coyotes also prey on deer, sheep, goats and elk.

Cowan (1943) studied food habits of the coyote in BNP, JNP and KNP. He found that mule deer and elk (primarily as carrion) formed the largest portion of the diet in both summer (49%) and winter (72%). Rodents (mainly Columbian ground squirrel and meadow vole) comprised 56% of the summer diet and 20% in winter. Bowen (1978) found similar results in coyote scats from the lower Athabasca River valley in JNP. He found that coyotes relied heavily on ungulates, especially in winter. Microtine voles, mainly meadow voles were a major prey item from mid-winter to early spring and Columbian ground squirrels were the major summer food item. Of the ungulates, mule deer and bighorn sheep were the principal prey species.

In KNP, between 1951 and 1983, there were 30 recorded instances of predation by coyotes: 5 were on mule deer (3 successful, 2 attempted) 3 on elk (1 successful, 2 attempted), 2 on bighorn sheep (1 successful, 1 attempted), 10 on microtines; 9 on Columbian ground squirrels; and 1 on grasshoppers (park wildlife cards). Before 1951 there were three instances of successful predation by coyotes: one on beaver; one on mule deer; and one on mountain goat. All the instances occurred in late autumn, winter or early spring.

Most of the ungulates eaten by coyotes are as carrion provided by highway-kills, other predator kills, winter kills and avalanches. Elk are the most common source of carrion, probably because of the high number of this species killed by motor vehicles (Sheehan 1982).

There are no records of coyotes mating in KNP. In BNP-JNP coyotes mate from early January to mid April (Holroyd and Van Tighem 1983). There were four records of coyote litters in KNP from 1951 to 1983 (park wildlife cards). Litter size ranged from 2 to 7 with a mean of 4.0. The mean litter size from BNP-JNP warden records (1945 to 1976) was also 4.0 (range 3 to 6) (Holroyd and Van Tighem 1983). Bowen (1978) found the mean litter size of coyotes in the lower Athabasca valley of JNP to be 5.5 based on placental scars.

There are only two records of coyote dens in KNP: one from the Settlers' Flats area in 1946 and one south of Redstreak campground in an HD3/C5 (white spruce-Douglas fir closed forest) inclusion in a WY2 Ecosite. Favoured denning habitat in BNP-JNP is well-drained, south-facing grassy slopes and open to semi-closed forests with greater than 50% deciduous canopy. Fluvial or glacial landforms were preferred (Holroyd and Van Tighem 1983).

There are kill records for 16 years from 1922 to 1941 that document the trapping and shooting of 103 coyotes as part of an intensive predator control program. The largest numbers were killed during the mid-1930's: 61 in 1933 and 34 in 1935. There are only a few records of coyote kills from 1941 to 1951. From 1953 to 1957, 21 coyotes were destroyed as part of the rabies control program.

The other major man-induced mortality factor, particularly in recent times, has been from collision with motor vehicles. Between 1951 and 1977 there were 15 coyotes killed on Highway 93 and from 1978 to 1982, 10 coyotes were killed (warden files).

Sarcoptic mange, as a result of infection by a mite (*Sarcoptes scabei*), causes hair loss and can be a direct or indirect cause of mortality of coyotes. There were two periods in which mange was reported in KNP coyotes: there were several reports of mangy coyotes from 1938 to 1941 and six reports from 1970 to 1973. The only other record is one in 1948.

MANAGEMENT CONSIDERATIONS

The coyote is an adaptable species and often thrives in association with man. It survived intensive predator control programs in KNP from the 1920's to the 1950's and is currently well established in the park.

The most recent threat to arise to this species is the increase in highway mortality. In the 26 years from 1951 to 1977 there were 15 coyotes reported killed on Highway 93 while in the last five years 10 have been killed. The actual mortality is probably higher, as injured animals that die away from the scene of an accident are not reported and as coyotes cause little or no damage to vehicles and are less noticable than ungulates it is likely that many collisions go unreported. Since much of the attraction to roadsides for coyotes is the availibility of carrion (specifically road-killed ungulates) the removal of these carcasses well away from the highway right-of-way, particularly in winter, will reduce the number of coyotes killed or injured by motor vehicles.

WOLF *Canis lupus* WOLF

STATUS AND DISTRIBUTION

Historically wolves occurred throughout most of Canada, except on the Queen Charlotte Islands. They are now extirpated from much of the southern portions of B.C., the Prairie Provinces, Ontario, Quebec, the Maritime Provinces and Newfoundland (Banfield 1974). Wolves occur on mainland B.C. and Vancouver Island mostly north of a line through Vancouver, Kamloops and Golden. They are scarce and localized in southern portions of B.C. and in the mountainous areas and have been virtually extirpated from the Kootenay and Thompson-Okanagan regions (Petticrew 1979).

KNP lies outside the modern day distribution of the wolf however they occasionally enter the park, primarily from the east. Cowan (1943) reported that in 1906 a trapper observed two wolves which were thought to have come up the Kootenay River from Canal Flats. Wolves were not reported again in the park until November 1946 when a pair were seen in the Marble Canyon District. In March 1947 a pair came over Vermilion Pass and moved south along the Vermilion River. A pair patrolled regularly from Mt. Eisenhower over Vermilion Pass to Numa Cr. during winter 1952-1953.

There were 23 warden records of wolves in Kootenay from 1951 to 1977. Wolves have been seen throughout the park in the Ochre, upper and lower Vermilion, lower Kootenay, Sinclair and Stoddart drainages with most sightings occurring in the lower Kootenay and lower Vermilion watersheds. From 1950 to 1959, four animals were seen; from 1960 to 1969, one was observed and from 1970 to 1979, 11 were seen.

In December 1981 a wolf was reported on a moose carcass near Kootenay Crossing and in February 1982 a wolf was seen near Sinclair Summit. Tracks were seen of a single wolf along Highway 93 near Nixon Cr. in April 1982. During the fall and winter of 1982-83 a total of eight wolves were observed: a family group of five (2 adults and 3 juveniles) and three lone adults. All eight were observed together at Daer Pond in January 1983. This was the first record of a wolf pack in the park. There is little indication of where the wolves originated, however a long-time resident and outfitter, A. Cooper (pers. comm.) reported a pack of at least 11 wolves in the upper Simpson River during 1981-82.

There were a total of 36 wolf tracks encountered during 315.4 km-days of winter track transects (0.4 tracks/km-day) in the lower Kootenay watershed and one track on one transect (0.03 tracks/km-day) in the upper Kootenay watershed. Sightings and sign of wolves during 1982-83 were all from Montane valley bottom and lower slopes from Vermilion Crossing in the lower Vermilion watershed to Pitts Cr. in the lower Kootenay. Activity was most abundant in the McLeod Meadows to Hector Gorge area, including Dear Pond and Dog Lake.

There have been only four wolf records during summer since 1951. The majority of sightings have been between November and April with a few from September and May. Three of the four summer records were from May and June of 1983 of lone individuals or tracks. No evidence of denning was found and no sightings of animals or sign were made during July and August of 1983. Wolves were sighted again during the winter of 1983-84 in the lower Kootenay (B. Sheehan, pers. comm.).

HABITAT

Habitat use by wolves is difficult to define or quantify in an ecological land classification framework because of their wide-ranging habits. Banfield (1974) indicated wolves show little preference for specific habitats, occupying arctic tundra, mountain tops, plains and coniferous and eastern hardwood forests. They are probably most influenced locally by prey availability (specifically ungulates) and therefore habitat use is largely determined by prey habitat use. Travel routes are influenced by the presence of roads and trails, which provide access to areas and habitats not otherwise used.

Specific winter habitat use by wolves was measured directly by winter track transects. Important Ecosites determined from winter tracking include (in descending order of importance): FR3, VL2, FR1, AT1 and DR5. Important vegetation types include: spruce-aspen-lodgepole pine (paper birch)/buffaloberry/pine grass (C44) forest, white spruce/buffaloberry/feathermoss (C37) forest, lodgepole pine/buffaloberry/pine grass (C38) forest, spruce/Labrador tea/brown moss (O11) open forest and dwarf birch-shrubby cinquefoil-willow/brown moss (S1) shrubland. These Ecosites and vegetation types are in the Montane Ecoregion and are all highly or very highly important to wintering elk and moose. Other highly important Montane Ecosites for wintering elk and moose include morainal and fluvial Ecosites in the Kootenay valley such as DR1, DR4, DG6, HD3, HD6, and VL6. Wolf Ecosite use in KNP is similar to BNP and JNP (Holroyd and Van Tighem 1983) .

Wolves use specific denning and rendezvous sites during spring and summer. Dens located by Carbyn (1974) in JNP were all in well-drained areas in the Montane and Lower Subalpine Ecoregions. He felt that site selection was based primarily on drainage and the nature of the soil. Rendezvous sites, occupied in June and July, are characterized by varied topography, diverse vegetation and open meadows and are generally located within 3.5 km of den sites (Carbyn 1974). Although no specific information is available for KNP, there were several areas in the lower Kootenay, frequented by wolves (specifically the Daer Pond-Dog Lake area), which have potential denning habitat in proximity to suitable rendezvous sites. Open shrublands and grassy meadows in the vicinity of suitable denning habitat have high potential as summer habitat for wolves.

SPECIES ATTRIBUTES

There are seven records of wolf predation in KNP from 1951 to 1983 (park wildlife cards). Six were on elk and one on two mountain goats which were unsuccessfully attacked by a wolf in February 1966 on Mt. Wardle. Four of the seven instances of predation were recorded during the winter of 1982-83: 3 male elk, including one yearling, and one female calf were known to have been killed by wolves. There were also several instances of wolves scavenging on elk road-kills in the lower Kootenay valley.

Elk were the most frequently preyed upon ungulates in BNP and JNP during winter followed by moose (Holroyd and Van Tighem 1983). In KNP, elk are the most abundant ungulate in the Kootenay and lower Vermilion valleys during winter and moose are second in abundance. Non-ungulate prey species included in the diets of wolves in BNP and JNP include beaver, microtine rodents, Columbian ground squirrels and ptarmigan (Holroyd and Van Tighem 1983).

MANAGEMENT CONSIDERATIONS

Wolves are restricted in the Main Ranges of the Rockies, particularly in winter, due to deep snow and a scarcity of wintering ungulates. They are presently increasing in JNP, but have become less abundant in BNP, especially in the Bow valley (Holroyd and Van Tighem 1983). In KNP wolves have only been transitory, however since the early 1970's more have been observed than during any previous time. An adequate ungulate prey base has always existed in the park so the recent increase in wolf occurrences may be the result of milder winters with below average snowfalls.

The occurrence of a pack of wolves in KNP during the past two winters bears close monitoring in order to accurately assess the status of this species in the park.

RED FOX *Vulpes fulva* REFO

STATUS AND DISTRIBUTION

The red fox is widespread and common in Canada (Banfield 1974). Foxes are distributed over most of B.C. except in the heavily forested slopes of the Coastal Mountains. The Caribou, Skeena and Omineca-Peace regions contain the majority of the estimated 10,000 to 14,000 red foxes with only 3% occurring in the Kootenay Region (Jackson *et al.* 1980).

The red fox is rare in KNP as it is throughout most of the Rocky Mountains. They are considered very rare in both BNP and JNP (Holroyd and Van Tighem 1983) and rare in YNP (McCrory and Blood 1978).

In KNP, warden Thompson reported tracks each winter in the early 1940's and warden Rutherford saw one fox at Sinclair Pass in December 1942 (Munro and Cowan 1944). There were four records during the winter of 1947-48: 3 in the Kootenay Crossing District and one in the Sinclair District. Between 1951 and 1977 there were only four warden records, all of single animals, including sightings at Marble Canyon in 1968 and 1969 and along the Kindersley Trail in 1968. There is only one record since 1977: one animal was seen crossing Highway 93 at McLeod Meadows in February 1982 (H. Kiliaan, CWS, Edmonton, pers. comm.) No further evidence of red foxes was found during the inventory.

HABITAT

The red fox is a species of "edge habitats" preferring semi-open country such as parkland, lakeshore, river valleys, natural clearings, agricultural areas as well as alpine and arctic tundra. They are seldom found in dense forests (Banfield 1974). Four of the five recent sightings of foxes in KNP, where specific locations were given, occurred near disturbed areas of semi-open habitat.

SPECIES ATTRIBUTES

There are no records of foxes breeding or denning within KNP and no observations of predation. Preferred prey species of foxes which occur in the park include: snowshoe hare, red squirrel, Columbian ground squirrel, meadow vole, deer mouse, beaver, ungulate carrion, Ruffed Grouse and frogs. The fact that foxes are rare may be a result of competitive exclusion by coyotes which are common, particularly in Montane valley bottom habitats, and rely on the same food source.

STATUS AND DISTRIBUTION

The black bear occurs throughout Canada south of the arctic. It is distributed throughout B.C. with an estimated population of 63,000 (Petticrew 1980).

Black bears are common and widespread in KNP. In 1933 there were 26 black bear records in the Kootenay Crossing District but in 1934 only 12 were reported (warden files). In 1934 eight black bears were reported in the Sinclair District and a "few" in the Marble Canyon District. In the autumn of 1937 there was a failure in the berry crop and bears were reported to be hungry. Munro and Cowan (1944) indicated that black bears were numerous and widely distributed throughout the Kootenay and Vermilion valleys north to Vermilion Crossing. Black bears were reported to be increasing in 1949.

There were 676 records of black bears between 1951 and 1977 (Table 4.7). They were seen frequently throughout KNP, particularly in the highway corridor: on 15 June 1959, 21 were seen from Radium to Vermilion Crossing and on 5 June 1960 17 were seen from McLeod Meadows to Vermilion Crossing. Most of the observations were from the lower Kootenay valley, particularly at Kootenay Crossing and McLeod Meadows. During the 1960's there was a marked decline in black bear observations but it is not possible to determine if the decrease in black bear sightings reflects an actual population decline or was due to a change in recording effort. Black bear distribution in the Vermilion valley appears to have shifted from a predominance of sightings in the upper Vermilion valley in the 1950's and 1960's to a predominance in the lower Vermilion valley in the 1970's. The decrease in black bear sightings from the upper Vermilion valley was because of the closure of the Hawk Cr. and Marble Canyon dumps in the early 1970's. The number of grizzlies sighted in the upper Vermilion valley went from two in the 1950's to 12 between 1970 and 1977 and if this represents an actual increase in the grizzly population, then the grizzlies may have been displacing black bears from the area.

There were 369 observations of black bears from April 1978 to August 1983 (park wildlife cards). The largest percentage of observations were from the lower Kootenay (38%) and Sinclair (25%) watersheds (Fig. 4.6).

HABITAT

Black bears occupy a variety of habitats in KNP including disturbed areas, and tend to prefer valley bottoms and coniferous forest associations. The only sources for black bear habitat use data in KNP are random observations by park and inventory staff which over-represent easily observed sites such as roadsides, campgrounds, picnic sites and inhabited areas (64.3% of the observations since 1978 were from these disturbed sites). Since 1978 black bears have been most frequently observed in valley bottoms and on lower slopes (Table 4.8). Of the natural habitats used, white spruce-Douglas fir closed forests, mixed forests and lodgepole pine forests showed the highest use. Open habitats counted for only a small percentage of the observations. Most observations were from the Montane Ecoregion between 1150 and 1400 m.

SPECIES ATTRIBUTES

Black bear are omnivorous, feeding on almost any animal matter and a wide variety of plants including grasses, sedges, forbs, buds, tubers and fruits. Banfield (1974) lists the annual diet as 76% vegetation, 8% insects, 15% carrion and 1% small mammals. Cowan (1943) analysed 13 faecal deposits from KNP and found 11 contained vegetation only, one contained vegetation and mule deer hair and one contained only mule deer hair. Of 121 warden observations of bears feeding on natural foods from 1951 to 1983, 94% were on vegetation: primarily grasses, sedges, dandelions and clover; and 6% were on carrion: deer (2 records), elk (2), moose (2) and black bear (1). There were 113 observations of black bears eating garbage at dump sites, campgrounds or residences or of taking food from tourists. Bears are attracted to roadsides and other disturbed sites in May and June by the early green-up of forbs and grasses and to campgrounds, picnic sites and residences because of garbage. As berry crops become available later in summer bears move into forested areas where they are less likely to be observed.

From 1951 to 1983, There were 109 observations of female black bears with 187 cubs, or 1.7 cubs per female. Black bears have a low reproductive rate as females do not breed until five to seven years of age

Figure 4.6. Black bear distribution in KNP from park wildlife cards, 1978-1983.

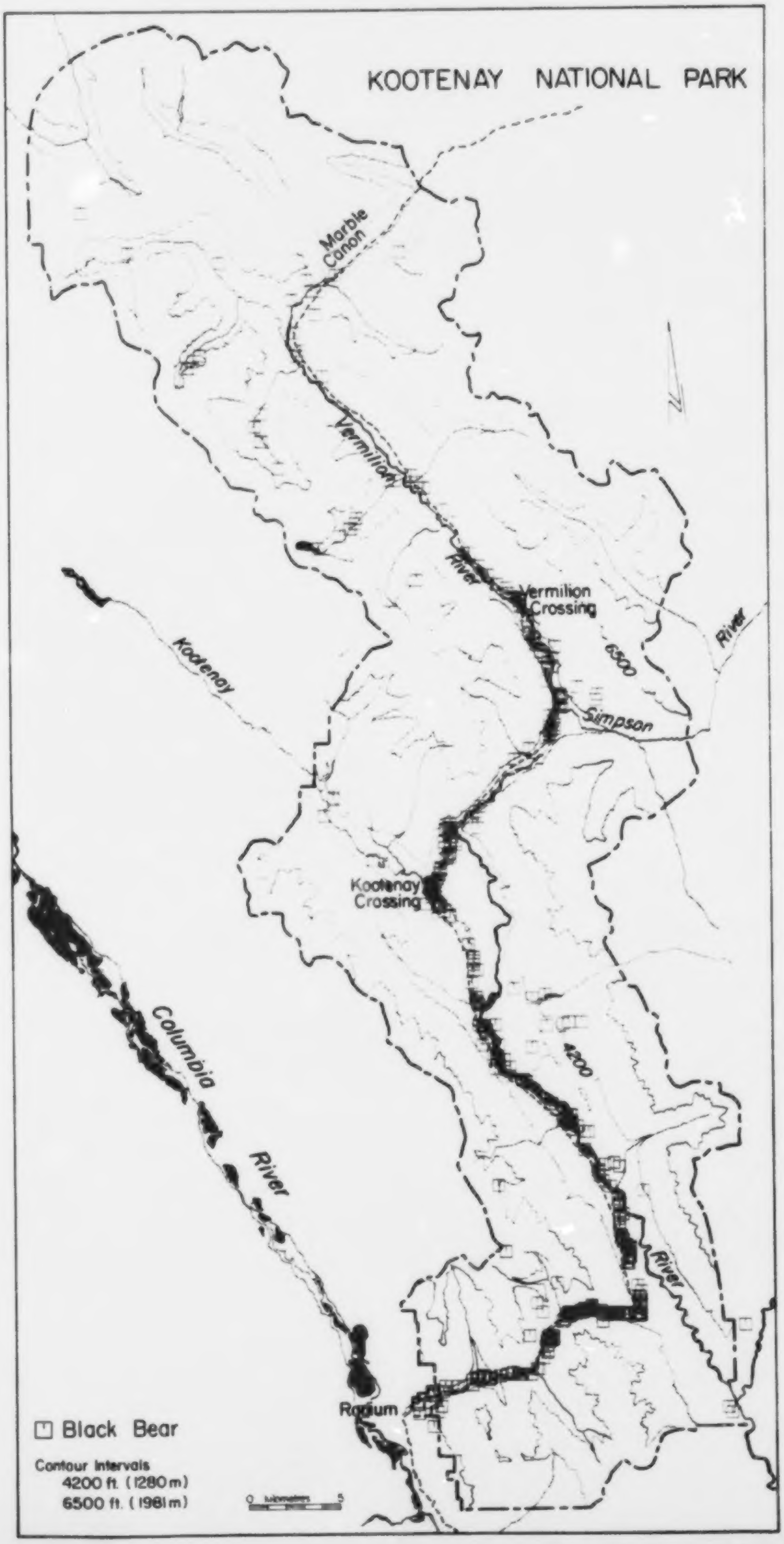

KOOTENAY NATIONAL PARK
Marble Canon
Vermilion
River
Vermilion Crossing
6500
River
Simpson
Kootenay
Kootenay Crossing
4200
Columbia
River
River
Radium
☐ Black Bear
Contour Intervals
4200 ft. (1280 m)
6500 ft. (1981 m)
0 kilometres 5

Table 4.7. Black bear distribution by watershed in KNP from park wildlife cards, 1951- 1977.

Watershed	1951-1959 (%)	1960-1969 (%)	1970-1977 (%)
Ochre	0.0	0.0	0.4
Tokumm	0.6	0.0	0.0
Vermilion-upper	36.4	32.3	8.9
Vermilion-lower	9.7	10.1	28.3
Simpson	0.0	1.0	0.4
Kootenay-upper	0.0	0.0	0.4
Kootenay-lower	43.0	42.4	45.7
Sinclair	10.3	14.2	15.9
Totals	100.0	100.0	100.0
(N)	(319)	(99)	(258)

Table 4.8. Percentage black bear observations by topographical position, habitat and elevation in KNP from park wildlife cards, 1978-1983.

Topographic position	%	Elevation (m.)	%	Habitat*	%
Pass	0.6	1981+	0.6	Coniferous closed	67.2
Ridge crest	0.3	1829-1980	1.4	Slidepath	8.8
Upper slope	0.8	1676-1828	1.4	Mixed or deciduous forest	4.8
Mid slope	8.8	1524-1675	5.4	Lake or pond	4.8
Lower slope	27.5	1372-1523	17.5	Coniferous open	4.0
Valley bottom	61.2	1219-1371	49.2	Rock	3.2
Floodplain	0.8	1067-11218	22.0	Open slopes	3.2
	-	914-1066	2.5	Other	4.0
Totals	100.0		100.0		100.0
(N)	(353)		(354)		(125)

*225 observations in "disturbed land", "man-made grassland" and "traffic surface" are not included under habitat.

and have litters of one to four young only every second or third year (Pelton 1982).

Since 1945 there are four records of natural mortality of black bears and 70 records of deaths from unnatural causes. The destruction of "problem" bears associated with dump sites, campgrounds and residences due primarily to inadequate garbage management has been the chief cause of black bear mortality in the park. Although there are 50 warden records of black bears being destroyed, warden John Taylor (pers. comm.) indicated that actually 105 black bears have been destroyed. The number of black bears destroyed each year varies from none to nine except in 1962 when 31 were destroyed. Between 1969 and 1973 eight black bears died because of problems during capture and removal. Highway mortalities have been the second chief cause of black bear mortality: there are 20 records of black bears being killed by motor vehicles between 1951 and 1983. This is a minimum figure since not all bear-vehicle collisions are recorded, particularly for injured bears that die elsewhere.

There are no records of black bear dens in KNP. Of four dens found in BNP all were located in dirt banks in coniferous forests of the Montane Ecoregion with north, south or west aspects (Holroyd and Van Tighem 1983) . Bears are dormant from November to April: the latest sighting in KNP was 27 November 1965; the earliest sighting was 3 April 1957.

MANAGEMENT CONSIDERATIONS

Black bears were a management problem in KNP at least as early as 1924. In March 1925, Mr. Harkin wrote to the park stating that "Several complaints have been received in connection with the depredations of bears at the tea room camps and other camps along the Banff-Windermere Road". He impressed upon the acting superintendent, H. Sibbald, "The necessity of preventing the bears from doing any real damage or causing any appreciable annoyance to the various camps" who replied in May that he had given instructions to the camps not to feed the bears and "This I think will help to keep the younger bears from becoming too tame and troublesome". However a human-bear encounter and subsequent complaint that summer indicates that Mr. Sibbald was not successful.

Throughout the early history of the park up to the mid-1960's and early 1970's, black bears were a constant problem at dump sites, campgrounds and residences. In addition to the number of bears destroyed each year there are 53 records of bears being trapped or tranquillized and relocated. There were also instances of people being injured in encounters with black bears, most of a minor nature involving single bears (John Taylor, pers. comm.). The removal of dump sites and many areas of human habitation within the park during the 1960's and early 1970's and improvements in garbage management practices were progressive steps in reducing conflict with bears. However, bear-human conflicts continue in KNP and will do so as long as intensive human activity continues in prime black bear habitats.

Bears, both grizzly and black, are probably the most intensively managed species throughout the mountain parks, in terms of manpower and resources but information on population status of black bears is lacking. Studies of black bear populations and habitats in the mountain parks are needed if the species is to be managed in an enlightened context.

GRIZZLY BEAR *Ursus arctos* GRIZ

STATUS AND DISTRIBUTION

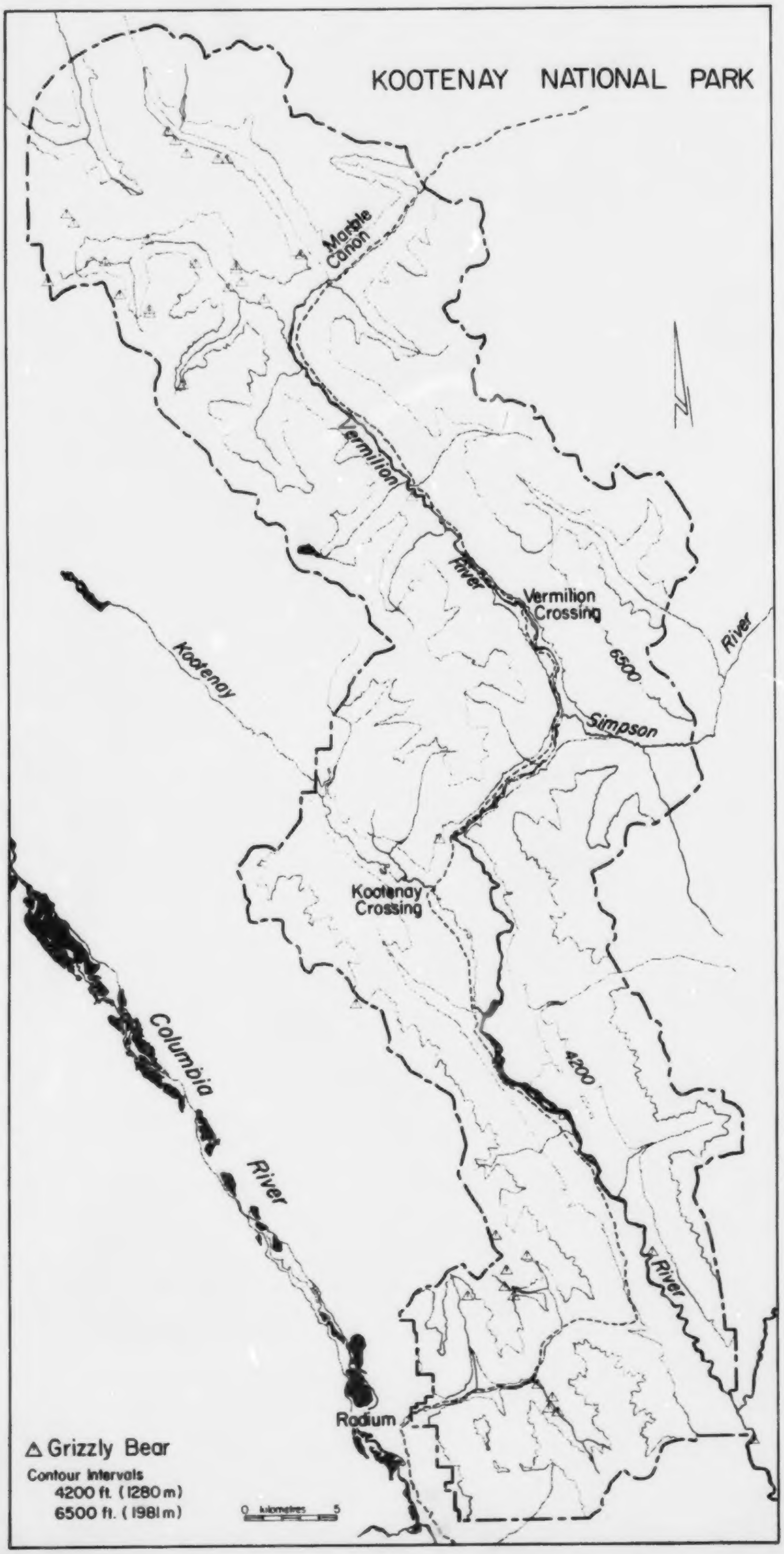
The grizzly bear occurs over much of the Yukon, B.C., western Alberta and the eastern and northern Mackenzie District and central Keewatin District, N.W.T. (Banfield 1974). It once occupied much of the western half of North America but was extirpated from Mexico, most of the United States and the Canadian Prairies (Rausch 1963). Grizzlies occur throughout most of the mountainous areas of B.C. and along the Pacific coast. The B.C. population is estimated at between 6000 and 7000 animals, 650 of which are estimated to occur in the Kootenay region (Pettirew 1979).

Grizzlies are distributed throughout KNP but are most common in the northwest and southwest portions of the park. They were not reported as often as black bears in the early years of the park. In 1934, grizzly bears were considered more numerous than black bears in the Marble Canyon District but were not reported from the Kootenay District. Munro and Cowan (1944) did not see any grizzlies in the summer of 1943 but they did observe old and recent sign of grizzlies along Tokumm and John McKay Cr. during June. Warden Thompson in 1939 reported seeing 11 grizzlies in one day on Tumbling Cr. (Munro and Cowan 1944). Ten were observed by wardens in August 1944, four in May 1946 and three in July 1947. These few records, however, do not provide a picture of grizzly bear abundance.

There are 96 records of grizzlies since 1951 (park wildlife cards). Grizzly bears were most frequently observed in the upper Vermilion (26% of observations), Ochre (22%) and Sinclair (12.5%) watersheds (Fig. 4.7). There was one observation in each of the Verdant and Stoddart Cr. watersheds.

Grizzly bear sightings have increased in number relative to black bear sightings. During the 1950's there were seven warden records of grizzly (2% of the total bear sightings), in the 1960's there were 13 records (10% of the total bear sightings) and during the 1970's there were 40 sightings (10% of the total bear

Figure 4.7. Grizzly bear distribution in KNP from park wildlife cards, 1978-1983.


KOOTENAY NATIONAL PARK
Marble Canon
Vermilion River
Vermilion Crossing
6500
Simpson River
Kootenay
Kootenay Crossing
Columbia River
4200
River
Radium
△ Grizzly Bear
Contour Intervals
4200 ft. (1280 m)
6500 ft. (1981 m)
0 kilometres 5

sightings). Since 1979 there have been 38 grizzly observations (10% of the total bear sightings). During 1981, 11 individual grizzlies were recorded; in 1982, 7 were seen; and in October 1983 there were 9 seperate grizzlies observed during aerial mountain goat surveys (Sheehan 1983). It is not possible to determine whether this increase in grizzly observations relative to black bears represents an actual increase in grizzly numbers or whether wardens have increased their backcountry travel in recent years.

HABITAT

Russell *et al.* (1979) and Hamer and Herrero (1983) have conducted detailed studies of grizzly bears in JNP and BNP, respectively. The only information available on grizzly bear habitat use in KNP is from random observations by park and CWS staff since 1978. There are 38 records of grizzlies between 1978 and 1983 for which specific habitat information was recorded.

Grizzly bears were most frequently observed on upper and middle slopes (32% and 29% of total observations respectively). They were most often seen on south and west aspects of slopes (34% and 18% of total observations respectively). Grizzly bears occur as low as 1127 m. and as high as 2468 m. Seventy-nine percent of the records occur above 1500 m. and fifty percent above 1800 m.

In contrast to black bears, grizzlies make little use of man-modified habitats (*eg.* roadsides and campgrounds). Grizzlies were seen most frequently on slidepaths (37% of total observations), in spruce/subalpine fir closed forest (24%), in alpine meadows (19%), wet shrub meadows and lake shores (8%) and other open habitats such as coniferous burns, scree slopes and open larch forests.

SPECIES ATTRIBUTES

There are 16 records of grizzlies feeding since 1951 (Park wildlife cards). Records of predation on ungulates include one on moose and one on elk and one attempted on elk. There were seven instances of grizzlies feeding on ungulate carrion: five on elk and two on moose. Additional food items reported once each include: unspecified roots, grasses and sedges, huckleberries and a Columbian ground squirrel. There are two records of grizzlies feeding on garbage. In BNP and JNP major ungulate prey are moose and elk while mule deer and bighorn sheep are also taken. Other prey items include golden-mantled ground squirrels and hoary marmots. Vegetation items eaten by grizzlies included buffaloberries, roots, grasses, dandelions and horsetail (Holroyd and Van Tighem 1983) .

Since 1951 there have been only five sightings of female grizzly bears with a total of eight young-of-the-year for an average of 1.6 cubs per female. There are records of nine females with a total of 12 young-of-the-previous year for an average of 1.3 yearlings per female. In BNP and JNP between 1945 and 1975 there were 160 observations of sows with 312 young-of-the-year or 1.95 per female (Holroyd and Van Tighem 1983) .

There are only two records of grizzly mortality in KNP: one was found dead of apparent natural causes in August, 1979 along lower Helmet Cr. and one was killed during an attempted capture and transplant from the Hawk Cr. dump in July 1961. There are no recorded highway mortalities of grizzly bears in KNP.

Grizzlies hibernate from November to April. The earliest spring record of grizzlies in KNP (1951-1983) is from Verendrye Cr. on 22 March 1983 (LRH, DMP); latest fall record is from 15 November 1973. There are no records of den sites in the park. Den sites in BNP are on slopes of NNE to ESE aspect where snow accumulates, at an average altitude of 2280 m. (Vroom *et al.* 1977).

MANAGEMENT CONSIDERATIONS

The relatively small size of KNP compared to the relatively large home range size of grizzlies makes it very likely that all the park grizzlies spend at least part of the year in other jurisdictions. The neighbouring parks (BNP and YNP) are protected areas for grizzlies, but hunting is permitted on adjacent B.C. provincial lands. Herrero (1982) estimates that as many as two-thirds or more of the grizzlies inhabiting KNP are subject to hunting which probably affects the numbers and behaviour of bears in the park. A cooperative program with the Province of B.C. to monitor the status of grizzlies in KNP and the adjoining region would provide insights into the status of the grizzly population.

The incidence of grizzly-human interactions in KNP is low because of the low number of bears and the relatively low levels of backcountry use. However, as backcountry use increases, the potential danger of human-grizzly encounters increases. Steps have already been taken in KNP to improve food handling and storage at backcountry campsites and a more rigorous system of recording grizzly observations was established in 1982. Potential high use habitats for grizzlies should be identified using the 1:50,000 Ecological Land Classification maps of Volume 1 (Achuff *et al.* eds. 1984) and by extrapolating from habitat use as recorded in BNP (Hamer and Herrero 1983) so that future trail and campground development can be adjusted to avoid prime grizzly habitat.

MARTEN *Martes americana* MART

STATUS AND DISTRIBUTION

Marten are common in the coniferous forest regions of Canada and are found throughout the forests of B.C., except on some of the smaller off-shore islands.

The marten is widespread and abundant in KNP, being found in all watersheds. During the inventory, 494 marten tracks were counted in 315.4 km-days of winter tracking for an overall average of 1.6 tracks per km-day. Highest winter track densities were in the upper Vermilion valley and Main Range watersheds.

The status of marten prior to 1932 is unknown. In 1932 the wardens noted that marten were much more plentiful than for some years past in the northern portion of the park. In 1934 marten were reported to be numerous in Marble Canyon District. In December 1940 marten populations were considered to be increasing at Marble Canyon and one marten was recorded at Wardle Cr., the first there in 20 years. Between 1945 and 1947 they were also reported to be increasing in numbers.

Munro and Cowan (1944) reported that marten were abundant throughout the subalpine forest of KNP. A trap line along the east boundary of the park in the Simpson valley yielded 21 marten pelts in the winter of 1941/1942. There were 47 sightings of marten from 1951 to 1977 park wildlife cards. Harris (1976) noted that marten were observed in the Vermilion Pass burn from 1973 to 1977 and that thirteen individual marten were identified in 1975.

HABITAT

The marten occurs in all Ecoregions sampled, with the highest density being 2.69 tracks/km-day in the Upper Subalpine, 2.28 in the Lower Subalpine and 0.93 in the Montane. Highest recorded marten track densities were in the following vegetation types:

Engelmann spruce-subalpine fir/false azalea (C14) forest
Engelmann spruce-subalpine fir/grouseberry (C15) forest
Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) forest
Engelmann spruce-subalpice fir/Labrador tea/crowberry (C30) forest
white spruce/buffaloberry/feathermoss (C37) forest
subalpine larch-subalpine fir/grouseberry-everlasting (C23) forest
subalpine larch-subalpine fir/heather (O13) open forest
lodgepole pine/twinflower-fireweed (S5) regenerating burns

For abundance rankings in the Wildlife Legend of the Map Supplement and Ecosite accounts in Volume I, a relative density of more than 3.0 tracks per km-day is considered high; 1.0 to 3.0, medium, and less than 1.0, low.

FISH

FISHER *Martes pennanti*

STATUS AND DISTRIBUTION

The fisher occurs locally at low population densities in forested habitat from New Brunswick to B.C. It inhabits most forested regions of B.C. north of the 50th parallel of latitude as well as areas south of this latitude in the Cascade and Coast Ranges. Its dependance on closed forests and its susceptibility to trapping have led to a considerable reduction in range and population levels (Brander and Brooks 1973).

The fisher is extremely rare in KNP. The only record is one seen on Tokumm Cr. in 1911 (Munro and Cowan 1944). Banfield (1958) indicates that fishers are extirpated from the Kootenay Region south of Yoho National Park, however possible fisher tracks were seen on 1 February 1983 at the meadows near lower Dolly Varden Cr. (DMP).

ERMI

SHORT-TAILED WEASEL *Mustela erminea*

STATUS AND DISTRIBUTION

The short-tailed weasel (or ermine) is widely distributed across Canada. It is the commonest and most widespread weasel in B.C., occurring throughout the province except on some of the smaller off-shore islands.

The short-tailed weasel is common in KNP and is the only weasel for which there are verified records. Virtually all records of "weasel" for KNP in the park wildlife records are undoubtedly records of short-tailed weasels. Munro and Cowan (1944) trapped one short-tailed weasel. During the inventory, 231 short-tailed weasel tracks were recorded during 315.4 km-days of winter tracking (0.73 tracks/km-day). Track densities did not vary significantly from one part of the park to another.

HABITAT

The short-tailed weasel occurs in all Ecoregions sampled, being most abundant in the Upper Subalpine (0.97 tracks/km-day) and least abundant in the Montane (0.62 tracks/km-day).

Highest short-tailed weasel track densities were in:

Engelmann spruce-subalpine fir/feathermoss (C13) forest
Engelmann spruce-subalpine fir/false azalea (C14) forest
Engelmann spruce-subalpice fir/Labrador tea/crowberry (C30) forest
subalpine larch-subalpine fir/grouseberry-everlasting (C23) forest
lodgepole pine/juniper/bearberry (C3) forest
western red cedar/oval leaf blueberry (C42) forest
spruce/Labrador tea/brown moss (O11) open forest
yellow dryad-willow herb (H8) flats

Moderate densities were in:

white spruce-Douglas fir/feathermoss (C5) forest
white spruce/buffaloberry/feathermoss (C37) forest
lodgepole pine/false azalea/grouseberry (C20) forest
dwarf birch-shrubby cinquefoil-willow/brown moss (S1) shrub wetland
everlasting-grouseberry (H17) meadow

For abundance rankings in the Wildlife Legend of the Map Supplement and Ecosite accounts in Volume I, a relative density of more than 1.5 tracks per km-day is considered high; 0.7 to 1.5, medium; and less than 0.7, low.

LONG-TAILED WEASEL *Mustela frenata* LOWE

STATUS AND DISTRIBUTION

The long-tailed weasel occurs across the southernmost portions of Canada and in the interior of B.C. as far north as Prince George. The long-tailed weasel is most often associated with shortgrass plains, northern prairie or aspen parkland habitats.

There are no verified records of this species in KNP. There are two records of long-tailed weasels in KNP (Park Wildlife cards) from 1969 and 1970 but the identification to species is uncertain and they could have been short-tailed weasels. No long-tailed weasels were recorded during inventory work from 1981 to 1983. The long-tailed weasel is uncommon in BNP and JNP (Holroyd and Van Tighem 1983) and could possibly occur in very low numbers in KNP.

MINK *Mustela vison* MINK

STATUS AND DISTRIBUTION

The mink occurs throughout Canada. The B.C. Fish and Wildlife Branch considers this to be the province's third most abundant mustelid species with an approximate population of 4500 in the Kootenay Region (Munro and Jackson 1979).

The mink is rare in KNP because suitable habitat is limited. Munro and Cowan (1944) reported the mink as "not particularly common" in KNP. They trapped one at Vermilion Crossing and reported that wardens saw mink tracks occasionally along the Kootenay River and Dolly Varden Cr. In 1944 the warden service subjectively estimated that there were 10 mink in KNP. Since then there have been 3 sightings of mink and two records of tracks (Park wildlife cards; inventory data) in areas from the lower Kootenay River valley up to the Vermilion Pass burn.

HABITAT

Cowan and Guiguet (1965) describe mink habitat as "...woodland and marshes surrounding sea-shores, banks of rivers, lakes and streams." In KNP mink occur mainly in the Montane Ecoregion in wetlands and valley bottom Ecosites such as FR1 and AT4.

RIVER OTTER *Lutra canadensis* OTTE

STATUS AND DISTRIBUTION

The river otter occurs across Canada except on the northern tundra and the semi-arid prairie regions.

The river otter is rare in KNP. The only records are from Dolly Varden Cr. in the 1940's. There were tracks and slides along Dolly Varden Cr. in the winter of 1941/42 (Munro and Cowan 1944). In January 1944 warden Meredith expressed concern about an otter in this creek and its impact on fish and beaver. He was advised that since this was the only otter in the park it should be left alone. There have been no records of otters in KNP since then.

HABITAT

Otters breed in deep rivers, lakes, large marshes and ocean bays but they may be found travelling along any permanent water body. KNP does not have the requisite habitat to support a population of otters and they are not likely to occur except as occasional wanderers.

WOLVERINE *Gulo luscus* WOLV

STATUS AND DISTRIBUTION

The wolverine is widespread and uncommon in the western and northern areas of Canada. In the Kootenays, there are estimated to be 9% of the provincial population of 5000 to 8000 wolverine (Munro and Jackson 1979).

Wolverines are uncommon throughout KNP. Wolverines were reported in 1925 and 1927 when one was trapped each year. In 1934 there were one or two tracks reported in the Marble Canyon District and three were estimated to be in the Sinclair District. In the early 1940's wolverine tracks were seen by wardens every winter and in the winter of 1941-1942 one was trapped at Simpson River (Munro and Cowan 1944). In 1944 the wardens estimated there were 20 in the park while in 1947 they considered wolverines to be abundant and increasing in the Marble Canyon District.

There are 40 records of wolverine between 1951 and 1977 distributed throughout the park (park wildlife cards). Half of the sightings were in the upper Vermilion watershed especially around the Hawk Cr. dump in the late 1950's.

During the inventory, 26 tracks of wolverine were recorded in 315.4 km-days of tracking, for an average of 0.082 tracks per km-day. Most records were in Main Range watersheds.

HABITAT

In KNP the wolverine occurs from the Montane up to the Upper Subalpine at all seasons. In winter, wolverines reach relative densities of 0.10 tracks/km-day in the Montane and Upper Subalpine Ecoregions and 0.05 in the Lower Subalpine.

Although it is difficult to extrapolate from the low number of tracks recorded, the wolverine is found in high densities on BY3 and SX1 and medium densities on HC1, DR7 and DR8. Wolverines will cross a large number of Ecosites and vegetation types in their extensive winter travels and can be expected in virtually any Ecosite. The bulk of the wolverine winter track records (69%) came from the Montane Ecoregion of the upper Kootenay River watershed (DR7, DR8, FR1) and 19% from the upper Vermilion watershed.

For abundance rankings in the Wildlife Legend of the Map Supplement and Ecosite accounts of Volume 1 a relative density of more than 0.6 tracks per km-day is considered high; 0.2 to 0.6, medium; and less than 0.2, low.

AMERICAN BADGER *Taxidea taxus* AMBA

STATUS AND DISTRIBUTION

The American badger occurs on the prairies and in the mountain valleys of southeastern B.C. The B.C. population is estimated to be from 100 to 1000, with 40% of those occurring in the Kootenay Region (Munro and Low 1979). It is listed as threatened in B.C.

The badger is rare in KNP. Munro and Cowan (1944) noted that badgers enter the park along the Kootenay River and they observed burrows in a colony of Columbian ground squirrels on the Kootenay River flats along Settler's Road. From 1964 to 1982 there were only five records in KNP (park wildlife cards). On June 1968 one was seen hunting Columbian ground squirrels at Kootenay Crossing. The other four records were of single animals seen near the West gate. None were recorded during the inventory.

HABITAT

All recent records are from the Montane Ecoregion, on WY1, WY2 and AT1. Badgers prefer meadows or open forests where there are colonies of one of their principal prey species, the Columbian ground squirrel, and where they can dig burrows into the friable soil.

MANAGEMENT CONSIDERATIONS

This species is of special interest because of its threatened status in the province. Protection or enhancement of known and potential badger habitat may contribute significantly to the preservation of this species in B.C.

STRIPED SKUNK *Mephitis mephitis* SKUN

STATUS AND DISTRIBUTION

The striped skunk occurs throughout southern Canada. It occurs at low elevations throughout B.C. east of the Coast Ranges and in the lower mainland.

The striped skunk is rare in KNP. Skunks are most often observed near the west gate of the park (6 observations) and occasionally in the lower Kootenay valley. It has also been observed in the Kootenay valley south of KNP (LWG). Munro and Cowan (1944) noted that one was killed by a car at Kootenay Crossing and one was also sighted there in 1968. A skunk was killed on Highway 93 at the entrance to Sinclair Canyon in August 1982.

HABITAT

Skunks frequent "...open fields, marshes and streamside thickets mixed with dense cover" (Cowan and Guiguet 1965). All records have been from the Montane Ecoregion from dry lodgepole-pine forest, dry douglas-fir forest or disturbed areas. Six of the seven records (park wildlife cards) are from WY2.

COUGAR *Felis concolor* COUG

STATUS AND DISTRIBUTION

The cougar is known from across southern Canada, but has been severely reduced or extirpated from its central and eastern Canadian ranges. It is presently most abundant in B.C. and the Rocky Mountains of Alberta. Cougar occur across southern B.C. and Vancouver Island, but are rare north of latitude 54°N (Cowan and Guiguet 1965). They are most numerous on Vancouver Island, and in the Fraser, Chilicotin, Thompson, Okanagan and Kootenay regions. Of the estimated 3500 cougars in B.C., 15% occur in the Kootenay Region (Goodchild *et al.* 1980). They are considered fairly common in the Columbia-Kootenay area as far north as Golden.

Cougars have been present in KNP since it was established. They were first reported in 1921 when warden Dilworth saw one in January at Kootenay Crossing and warden MacDonald saw one in April at Twelve Mile on Sinclair Road. A cougar was trapped and killed in 1927. There are no records from the 1930's. In the monthly report of December 1940 there were estimated to be 2 or 3 cougars in the park. Cowan (1943) doubted if the park provided the entire home range for even one animal. He suggested that warden Thompson's 1943 observation of tracks of five animals between Radium and Wardle Cr. represented the entire population of cougars ranging across the park at that time. He also reported that there were no breeding records of cougar for KNP up to that time. Cougar were mentioned in seven monthly reports from 1946 to 1948. Two were reported in the Marble Canyon District in December 1946 while there were single records from there in October 1946 and October 1947. Single animals were also reported from Kootenay Crossing District in October 1947 and January 1948 and from Sinclair District in December 1947.

There were 68 warden records of cougar between 1951 and 1977. The majority of sightings (78%) were in the southwest portion of the park: 43% in the lower Kootenay valley, 22% in the Sinclair and 13% in the Stoddart watersheds. Young-of-the-year were observed in Sinclair Canyon in 1969, 1972 and 1973 and at

Table 4.9. Seasonal use of Ecosites by cougar from park wildlife cards, 1951-1982.

Ecosite	Winter (Dec-Feb)	Spring (Mar-May)	Summer (Jun-Aug)	Autumn (Sept-Nov)	Total
Montane					
AT1 pine	1			1	2
AT4 spruce/mixed	2		1	6	9
DR3 Douglas fir	2		2	1	5
DR4 aspen/mixed			1		1
DR5 Douglas fir	2		1	2	5
DR6 mixed	1				1
DR7 pine		2	1	2	5
DR8 pine-shrub	3		1	2	6
DG3 open Douglas fir grassland	3				3
FR1 pine	2		1	2	5
FR3 mixed			1	3	4
HD3 mixed				1	1
HD6 herb mat				1	1
VL2 shrub				2	2
VL6 open forest	3	3		1	7
WY2 open Df			1		1
Lower Subalpine					
BY3 pine	1				1
Upper Subalpine					
PL6 spruce-fir			1		1
WF6 Aval cplx		2		1	3
Alpine					
BS2 tundra			1		1
TOTALS	20	7	12	25	64

Stoddart Cr. in 1975. There was one sighting of cougar or their sign each year between 1977 and 1982: tracks along the East Kootenay fire road in November 1978; one animal along the West Kootenay fire road in November 1978, two 2.0 km. south of Kootenay Crossing in January 1980; one crossing Settler's Road at Mile 2.5 in October 1981 (MJH); and tracks on an Alpine ridge above Silt Cr. in July 1982 (DMP). In April of 1982 a yearling female mule deer was killed by a cougar at the John McKay Cr. compound. Cougar tracks had been seen several times during the winter of 1981-82 by park maintenance personnel in the lower John McKay Cr. drainage.

Since 1951, cougar or their sign have been recorded in all major watersheds of KNP except Ochre Cr. and Verdant Cr. As mentioned above the large majority of observations have been from the lower Kootenay, Sinclair and Stoddart watersheds.

HABITAT

Cougar are most common in the Montane Ecoregion in valley bottoms particularly in autumn and winter where ungulates congregate and snow accumulation is low (Table 4.9). Cougar were most frequently observed during autumn and winter (39 and 31% of observations respectively). Habitats in which they were most frequently observed include: lodgepole pine forest, mixed forest, Douglas fir forest and Montane spruce meadow.

As with most large carnivores, the availability of prey is a major influence on habitat use. To establish the potential importance of Ecosites to cougar in KNP, a weighted ranking system was used (see Volume I: Walker *et al.* 1984) based on the habitat preferences of the cougar's major ungulate prey species: mule deer, elk and bighorn sheep.

SPECIES ATTRIBUTES

In BNP and JNP the primary ungulate prey species are mule deer, bighorn sheep, elk, and mountain goat (Holroyd and Van Tighem 1983). Of 15 records of cougar predation in KNP since 1945, 8 were of elk, 3 of mule deer, 2 of mountain goat and 2 of snowshoe hare. There were no records of cougar killing bighorn sheep. The two goats killed were both at Mt. Wardle in the autumns of 1964 and 1968.

Cougars breed at any time of the year and the gestation period is about three months. The average litter size is 2 to 4 (Banfield 1974). There are two records of female cougars with kittens in KNP, from January 1969 and January 1975). A kitten was killed on the highway along Sinclair Cr. in September 1972. There is one denning record: naturalist L. Halverson located a den in a cave above lower Stoddart Cr. (DG3) on the park boundary in January 1975.

MANAGEMENT CONSIDERATIONS

The wide ranging nature of the cougar and the relative small size of the park make it highly unlikely that KNP contains the entire home range of even one animal. The greatest importance of the park to cougar is during fall and winter when they are attracted to the Montane valley bottoms and lower slopes of the Kootenay, Sinclair and Stoddart drainages where ungulates congregate and snow depths are favorable. The preservation of low-elevation wilderness within the park is important for the continued maintenance of this species as it is subject to hunting and habitat loss on adjacent provincial lands.

CANADA LYNX *Lynx lynx* LYNX

STATUS AND DISTRIBUTION

The lynx occurs throughout the boreal forest and aspen parkland of Canada. It is found throughout the Rocky Mountains, but is generally less common there than in the boreal forest. In B.C. the lynx occurs throughout the province except for the Coast Ranges. Trapping returns since 1920 show that lynx undergo a provincial ten-year cycle of abundance, peaking about the middle of each decade (Goodchild and Munro 1980). The Kootenay Region contains about 9% of the total B.C. population.

Lynx have never been common in KNP, but have been widely distributed since the park was formed. In 1916-1917, prior to the formation of the park, 29 lynx were trapped in the region. This period was known to be a peak year for lynx in other areas of B.C. The first park records of lynx are of animals killed during the predator control era when 12 lynx were killed in the park between 1922 and 1929. In 1934 there were reported to be four lynx in the Sinclair District and they were considered "not common" in the park overall. Munro and Cowan (1944) found the lynx to be rare in the southern end of the park; one track was seen on Sinclair Summit in the winter of 1942-1943. At that time, park wardens observed tracks regularly in the winter; sometimes of two or three animals, between Vermilion Crossing and Wardle Cr. In 1944 the estimated park population was six animals (park files).

There are 54 warden records of lynx from 1951 to 1983. Lynx have been observed throughout the park in the Ochre, upper and lower Vermilion, upper and lower Kootenay and Sinclair drainages. Most observations were from the lower Kootenay (33%) and lower Vermilion (31%) watersheds. The highest concentration of sightings are from the Hector Gorge-Mt. Wardle area and Kootenay Crossing.

During this inventory a total of 40 lynx tracks were recorded on 31 winter track transects. Tracks were most frequent in the Simpson (9.53 tracks/km-day) and upper Kootenay (0.39 tr/km-day) watersheds and were also recorded in the Tokumm (0.08 tr/km-day), upper Vermilion (0.06 tr/km-day), and lower Kootenay (0.03 tr/km-day) watersheds.

HABITAT

Lynx are most common in the Montane Ecoregion (0.10 tr/km-day) followed by the Lower Subalpine (0.02 tr/km-day). Important vegetation types were white spruce (C32), lodgepole pine (C16, C38, C39), Engelmann spruce-subalpine fir (C14, C42), Douglas fir and Douglas fir-white spruce (C5), and mixed coniferous-deciduous (C44) closed forests. As lynx are highly dependant on snowshoe hare, additional important habitats for lynx based on hare densities include: white spruce and Douglas fir open forests. Similar habitat preferences were noted for lynx in BNP and JNP (Holroyd and Van Tighem 1983) .

SPECIES ATTRIBUTES

Studies elsewhere have shown that lynx populations undergo functional and numerical responses to changing snowshoe hare densities (Nellis *et al.* 1972; Brand *et al.* 1976; Keith *et al.* 1977). The paucity of snowshoe hare and lynx records in KNP precludes identification of cyclic fluctuations in abundance.

In central Alberta, Nellis *et al.* (1972) reported the winter diet of lynx to consist of 76% snowshoe hare, 9% Ruffed Grouse, 3% red squirrel and 10% carrion. There were only two records of lynx predation in KNP from 1951 to 1983: one record of a lynx preying on a hoary marmot and one on fish. There were nine records of lynx eating carrion: six on deer carcasses and three on elk. Other prey species that have been reported and that occur in KNP include northern flying squirrel, deer mouse, masked shrew, Columbian ground squirrel, beaver, Gapper's red-backed vole and meadow vole (van Zyll de Jong 1966).

There are no records of breeding or denning by lynx in the park. There was one record of a female with four kittens in the Mt. Wardle area in December 1972. Banfield (1974) reports that lynx breed in March and April and young are born from mid-May to mid-June. The average litter size is between two and three and there is only one litter per year. Pregnancy rates and litter sizes decrease during periods when snowshoe hares are at low numbers (Brand and Keith 1979).

MANAGEMENT CONSIDERATIONS

The lynx is common in KNP most years, but never abundant. It is subject to trapping on adjacent provincial lands and therefore the park provides an important sanctuary.

Snowshoe hares and lynx were likely more abundant during the 1920's and 1930's when early-successional forests were abundant, particularly in the Kootenay valley following the 1926 burn. Snowshoe hares become particularly abundant in post-fire successional forests (Grange 1965). The lack of fire, partly due to fire supression, has steadily reduced the extent of this type of forest in KNP and thus the ability to support large numbers of hare and lynx.

BOBCAT *Lynx rufus* BOCA

STATUS AND DISTRIBUTION

The bobcat is found across the southern most portion of Canada from B.C. to Nova Scotia. In B.C., it ranges north to Fort St. John, however the majority occur in the dry southern interior parts of the province. Fifty percent of the bobcats in B.C. are believed to occur in the Kootenay Region (Goodchild and Munro 1980).

The bobcat is rare in KNP. According to Munro and Cowan (1944), tracks seen in the snow on Sinclair Summit in 1935 constituted the only record of the species in the park to that time. There are 11 records of bobcat since 1951 (park wildlife cards). Sightings have been reported in the Ochre (1), upper (1) and lower (2) Vermilion, lower Kootenay (2) and Sinclair (4) drainages. Five of the 11 records were between 1972 and 1975. Eight observations were during winter (December-February), one during March and one each in June and July.

HABITAT

Bobcats are found in a wide variety of habitats including swamps, woodlots, second-growth forests, deserts and rocky slopes (Banfield 1974). In B.C. they tend to prefer low elevation valley bottoms where mixed cover predominates (Cowan and Guiguet 1965). They are less adapted to cold and deep snow than lynx and for this reason only occur sporadically in the mountain parks. All the KNP observations were from Montane and Lower Subalpine valley bottoms usually in association with the highway and other disturbed sites.

SPECIES ATTRIBUTES

Bobcats prey primarily on small mammals and occasionally on deer. Their diet consists chiefly of Lagamorphs (45%), mice and rats (28%) and squirrels (10%) (Banfield 1974). There is only one record of a bobcat feeding in the park: one was observed feeding on a bighorn sheep carcass in Sinclair Canyon during January 1975.

MANAGEMENT CONSIDERATIONS

The bobcat is rare and sporadic in KNP. The great similarity to its relative the lynx plus its comparative lack of adaptation to cold weather and deep snow makes some of the KNP records, particularly in the northern portion of the park, questionable. The more severe winters in the park compared to areas to the southwest makes much of the park unsuitable for this species. There is one specimen: a road-kill from the lower Kootenay valley in January 1980. The large majority of bobcat sightings have been during winter in valley bottom areas associated with Highway 93 suggesting that this species is restricted to low elevations in winter due to deep snow and that it may be attracted to the highway corridor by the prevalence of ungulate carrion. To reduce the potential for highway mortalities of bobcat as well as other large carnivores, road-killed ungulates should be moved away from the highway corridor, especially in winter.

ELK *Cervus elaphus* **ELK**

STATUS AND DISTRIBUTION

Historically, elk ranged in Canada from B.C. to southern Ontario and the eastern Townships of Quebec (Banfield 1974). The current distribution of elk is limited to the four western provinces with many populations occurring within park boundaries. In B.C. elk were historically widely distributed but only locally abundant. It is currently estimated that 56% (13,400) of the B.C. elk population is in the Kootenay Region of southeastern B.C. (including the Rocky, Purcell, Selkirk and Monashee Mts.) (Petticrew and Fyfe 1981).

Elk declined dramatically on the east slopes of the Rockies from the mid to late 1800's (Holroyd and Van Tighem 1983). Similar declines occurred about 1900 in the Kootenays. Severe winters and overhunting were cited as causes for the declines (Soper 1970, Petticrew and Fyfe 1981). The East Kootenay population began increasing and expanding its range north by the late 1920's and elk were present in the Big Bend area by 1927.

Early records of elk in KNP are scant. A few records in park files indicate that elk were increasing throughout the 1930's and 1940's. This may have been in response to improved winter range conditions as a result of a major fire in the Kootenay valley in 1926 (Munro and Cowan 1944). Cowan (1943) listed elk as abundant and widespread in KNP and suggested that the major winter range, between Kootenay Crossing and Wardle Cr. was fully stocked and could not support many more ungulates without serious damage to vegetation. Warden Meredith (park files) estimated the population at 500 in 1944 and felt that the winter range was overstocked. He was given permission to slaughter 30 elk during winter 1944-45 to provide meat for the Alternate Service Workers (ASW) camp at Hawk Cr. A total of 40 were slaughtered by January 1945.

Population estimates between 1945 and 1957 indicate that elk exceeded 1000 animals by 1956-57. Warden T. Gibbons (pers. comm. 1981), however, suggested that many population estimates during this period were aggregate totals from three day counts taken in each Warden District and undoubtedly contained much duplication. He estimated the actual population to be 500-600 animals during this period. A summary of elk population figures for the past 30 years is shown in Table 4.10. Figs. for 1952 to 1974 are taken from a

Table 4.10. Maximum counts of elk in Kootenay National Park, from park files, 1952-1982.

Year	Bulls	Cows	Calves	Yearlings			Unclass.	Total	Calves per 100 cows
				M	F	U			
1952	123	720	156			109		1108	22
1953	151	751	94			142		1138	13
1954	111	325	38			18	381	873	12
1956	83	414	11			64	446	1018	3
Oct 1962	36	191	138	35				400	72
Nov 1963	68	260	117	39				484	45
Nov 1964	58	223	101	22				404	45
Nov 1965	46	188	100	20				354	53
Nov 1966	64	155	80	17	56			372	51
Nov 1967	58	238	102	16	26		4	404	43
Nov 1968	34	160	75	21	43			333	46
Oct 1969	54	157	69	11	31			322	43
Oct 1971	25	76	50	10			107	268	66
Oct 1973	20	172	50	16	35			293	29
Nov 1974	6	71	31	6	32		37	183	44
Nov 1976	14	133	49	26	31		25	278	37
Nov 1979	7	155	55	27	14		62	320	36
Nov 1980								204	
Nov 1981	17	137	31	15	13		52	265	23
Nov 1982	21	154	64	17	7			264	42

summary of annual Superintendant's reports by Boshe (1975). Subsequent counts were taken from park wildlife cards files and from surveys conducted during this inventory.

It is apparent, even though population figures from the 1950's are inflated, that elk in KNP reached peak numbers during the mid-1950's, declined through the 1960's and have remained relatively constant at 300-350 animals since then. The combination of an overstocked winter range and several severe winters during the 1950's no doubt led to the rapid decline in numbers. Forest succession since the last major fire in 1926 has, over the past two decades, reduced the available winter range.

Elk show a marked north-south seasonal migration pattern between the Vermilion and Kootenay valleys (see section 3.7). They make heavy use of man-made grasslands along the highway corridor between Nixon Cr. and Kootenay Crossing during late autumn and early winter. Use of the highway corridor decreases in midwinter as snow depths exceed 50-60 cm. and elk move to areas along Dolly Varden and Meadow Cr. and the upper Kootenay valley. A small band of elk also winters consistently in the lower Vermilion valley between Hector Gorge and the Simpson River. As snow recedes from the Vermilion valley in late April and May, elk move northward and summer concentrations occur from the Simpson River to Marble Canyon as well as in the Tokumm, Ochre, Verdant and Simpson drainages. The southward movement to winter range in the Kootenay valley begins in October and by mid-November most elk are south of Wardle Cr. (Figs. 4.8 and 4.9).

Concerns were expressed during the late 1960's that large numbers of park elk were wintering beyond the south boundary as far as Canal Flats, potentially conflicting with provincial herds and domestic livestock inhabiting these ranges (Gibbons and Baker 1976). Colour-marking and radio-telemetry studies conducted between 1972 and 1978 showed these concerns to be unfounded and that only limited transboundary movements of park elk actually occurred (Gibbons 1978a). Gibbons (1978a) reported that 20 to 30 elk wintered beyond the southern boundary to about the junction of the Palliser and Kootenay rivers. There was also a limited number of KNP elk found wintering outside the park in the Bow and Columbia valleys. It is likely, however, that severe winters with high snowfalls such as occurred in the early 1960's would force elk to move south in the Kootenay valley beyond the park boundary.

Table 4.11. Highly important vegetation types for elk in KNP from pellet group counts.

Vegetation type	Pellet groups /ha	Description
Spring and early summer		
C3	78.6	lodgepole pine/juniper/bearberry
C11	100.0	lodgepole pine-spruce/feathermoss
C16	175.0	aspen/hairy wild rye-peavine
C25	108.3	Engelmann spruce-subalpine fir/green alder
C39	70.6	lodgepole pine/buffaloberry/bunchberry
C41	100.0	white spruce-subalpine fir/bunchberry-horsetail
H8	175.0	yellow dryad-willow herb
H19	195.0	bluebunch wheatgrass-hairy wild rye-showy aster
O11	133.3	spruce/labrador tea/brown moss
O14	75.0	Engelmann spruce-subalpine fir/rock willow/bracted lousewort
S2	77.8	subalpine fir-willow/valerian avalanche
S5	88.9	lodgepole pine/twinflower-fireweed burn
Late summer, autumn and winter		
C1	108.8	Douglas fir/hairy wild rye
C9	175.0	lodgepole pine/dwarf bilberry
C16	325.0	aspen/hairy wild rye-peavine
C37	205.0	white spruce/buffalo berry/feathermoss
C44	177.8	spruce-aspen-lodgepole pine-(paper birch)/buffaloberry/pine grass
H8	600.0	yellow dryad-willowherb
H11		beaked sedge-water sedge
H10	759.0	bluebunch wheatgrass-hairy wild rye-showy aster
O11	516.7	spruce/Labrador tea/brown moss
S1	312.5	birch-shrubby cinquefoil-willow/brown moss

HABITAT

Elk occupy a variety of habitats in all three Ecoregions during summer. Greatest pellet densities were recorded in the Subalpine Ecoregion. Pellet densities averaged 56.4 groups/ha in the Upper Subalpine. Summer pellet densities averaged 39.5 groups/ha and 2.6 groups/ha in the Montane and Alpine, respectively.

In spring elk prefer Montane valley bottoms and southerly-westerly aspects. Highest use is on fluvial (FR1, VL6, HD6) and morainal (DR1, DR4, WY2) Ecosites with lodgepole pine (C3, C11, C39), spruce (C41), aspen-pine (C16) and Douglas fir (C1, C5, O5) forests, in association with herb meadow (H8) and grassland (H6, H19) openings. There is also heavy use of the grassy highway right-of-way and man-made clearings (Tables 4.11, 4.12 and Fig. 4.10).

As snowmelt progresses elk disperse to higher elevation glacial (BY7, CA2, CV1, PL1), fluvial (HC1, HD6) and colluvial (FV3, WF6, WH4) Ecosites with Englemann spruce-subalpine fir forests (C25, O14, O11), lodgepole pine (C20) forest and steep, open avalanche slopes with shrub (S2, S16, S10) and herb (H5, H22) meadows. Complexes of open meadows and dense forest are preferred. High densities of elk also occur in the Vermilion Pass burn (S5).

In general, during summer elk prefer Lower to Upper Subalpine avalanche shrub and herb meadow vegetation types adjacent to moist Engelmann spruce-subalpine fir closed and open forest. Lower summer pellet densities were recorded in spruce/fir forest, larch-fir forest, lodgepole pine-menziesia forest, and heath and

Table 4.12. Highly important Ecosites for elk in KNP based on pellet group counts.

Ecosite	Pellet groups /ha	Ecoregion	Landform	Vegetation
Spring and early summer				
AL4	100.0	L. Subalpine	fluvial	spruce-fir forest
BV2B	100.0	L. Subalpine	glaciofluvial	lodgepole pine burn
BY7	66.7	L. Subalpine	glacial	lodgepole pine forest
BY7B	200.0	L. Subalpine	glacial	lodgepole pine burn
CA2	242.9	L. Subalpine	morainal	spruce-fir forest
CV1	75.0	L. Subalpine	morainal	spruce fen
DR1	75.0	Montane	morainal	Douglas fir forest
DR4	175.0	Montane	morainal	aspen-pine forest
FR1	65.2	Montane	fluvial	lodgepole pine forest
FV3	250.0	L. Subalpine	colluvial	lodgpole pine forest
HC1	133.3	L. Subalpine	fluvial	open spruce-fir forest
HD6	180.0	Montane	glaciofluvial	dryas mat
IB4	75.0	L. Subalpine	landslide	spruce-fir forest
PL1	72.7	U. Subalpine	morainal	spruce-fir forest
VL6	133.3	Montane	fluvial	spruce forest
WF6	110.0	U. Subalpine	colluvial	avalanche shrub
WH4	83.3	U. Subalpine	colluvial	open spruce-fir-pine
WY2	100.0	Montane	glacial	Douglas-fir forest; grassland
Late summer, autumn and winter				
AT1	123.3	Montane	glaciofluvial	lodgepole pine forest
AT4	175.0	Montane	glaciofluvial	spruce forest
BV2		L. Subalpine	glaciofluvial	lodgepole pine-menzesia
BV2B	150.0	L. Subalpine	glaciofluvial	lodgepole pine burn
CA1	125.0	L. Subalpine	glacial	spruce-fir forest and spruce fen
CA2	135.7	L. Subalpine	morainal	spruce-fir forest
DR1	155.0	Montane	morainal	Douglas fir forest
DR3	90.0	Montane	morainal	spruce-Douglas fir forest
DR2	146.9	Montane	morainal	lodgepole pine forest
DR4	325.0	Montane	morainal	aspen-pine forest
FR3	207.1	Montane	fluvial	mixed forest
FV5	100.0	L. Subalpine	colluvial	Avalanche shrub>spruce-fir
HD6	970.0	Montane	glaciofluvial	dryas mat
VL2	312.5	Montane	fluvial	birch-willow shrub
VL6	516.7	Montane	fluvial	spruce forest
WY2	185.7	Montane	glacial	Douglas fir forest; grassland

alpine tundra (Fig. 4.10). The high importance of avalanche shrubs and herb meadow vegetation types to summering elk was also noted by Holroyd and Van Tighem (1983) in BNP and JNP and by McCrory and Blood (1978) in YNP.

During the rut (September to mid-October) elk were found to be most common in forested areas in the Lower Subalpine (CA1, CA2) and Montane (VL6) Ecoregions, as well as along Lower Subalpine avalanche

Figure 4.8. Elk distribution in KNP from park wildlife cards: winter and spring.

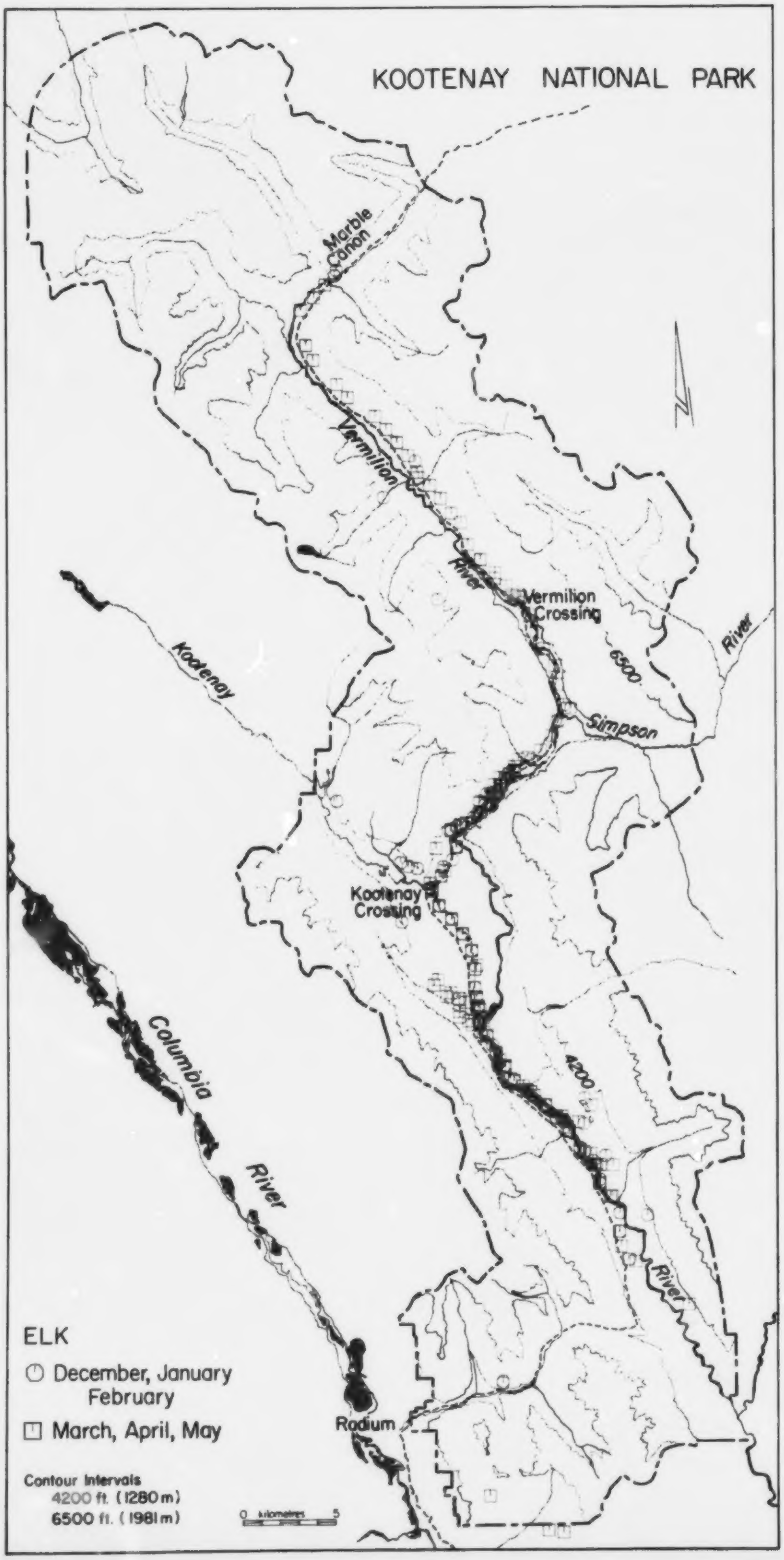

KOOTENAY NATIONAL PARK
Marble Canon
Vermilion
River
Vermilion Crossing
6500
River
Kootenay
Simpson
Kootenay Crossing
Columbia
River
4200
River
Radium
ELK
December, January February
March, April, May
Contour Intervals
4200 ft. (1280 m)
6500 ft. (1981 m)
0 kilometres 5

Figure 4.9. Elk distribution in KNP from park wildlife cards: summer and autumn.

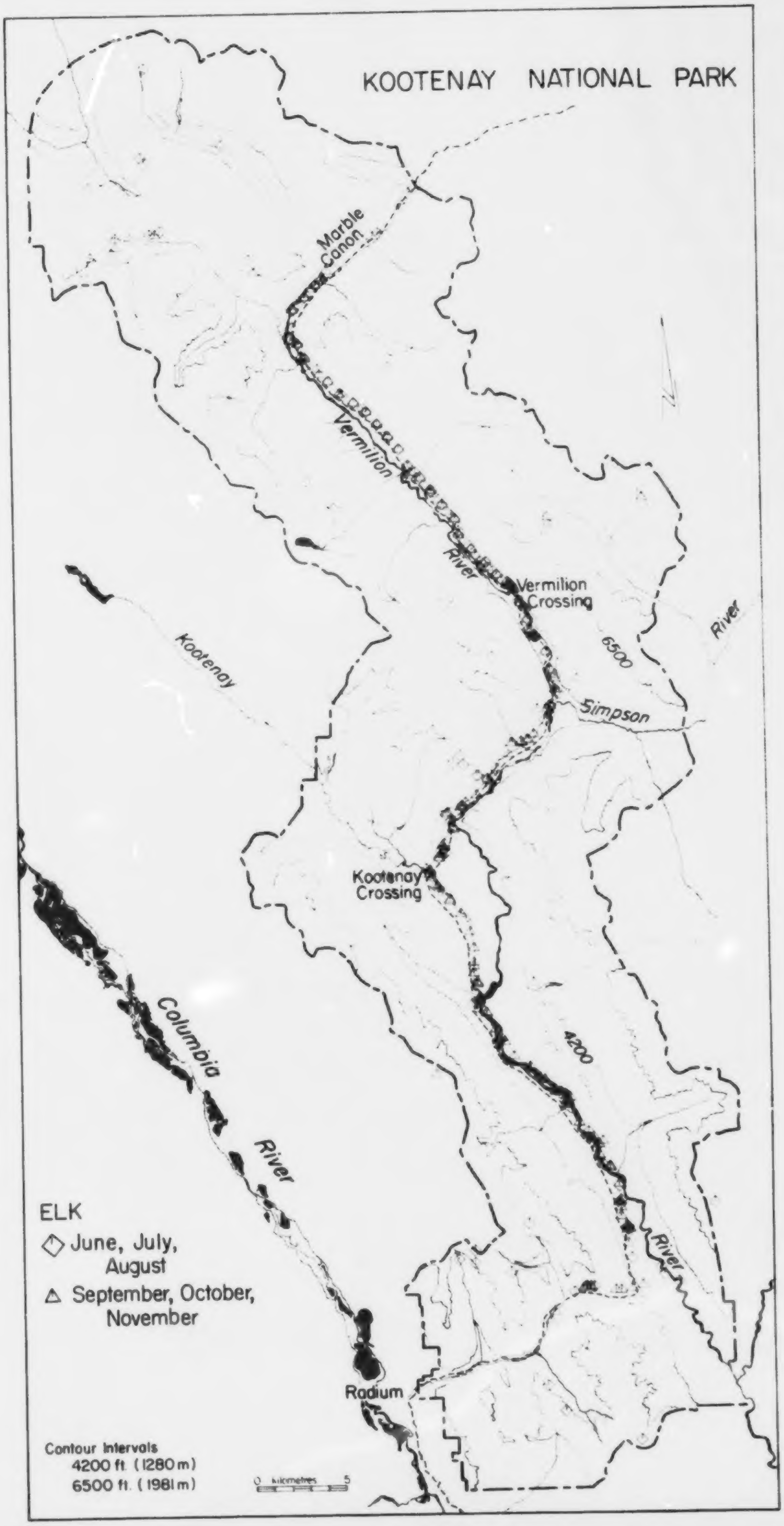
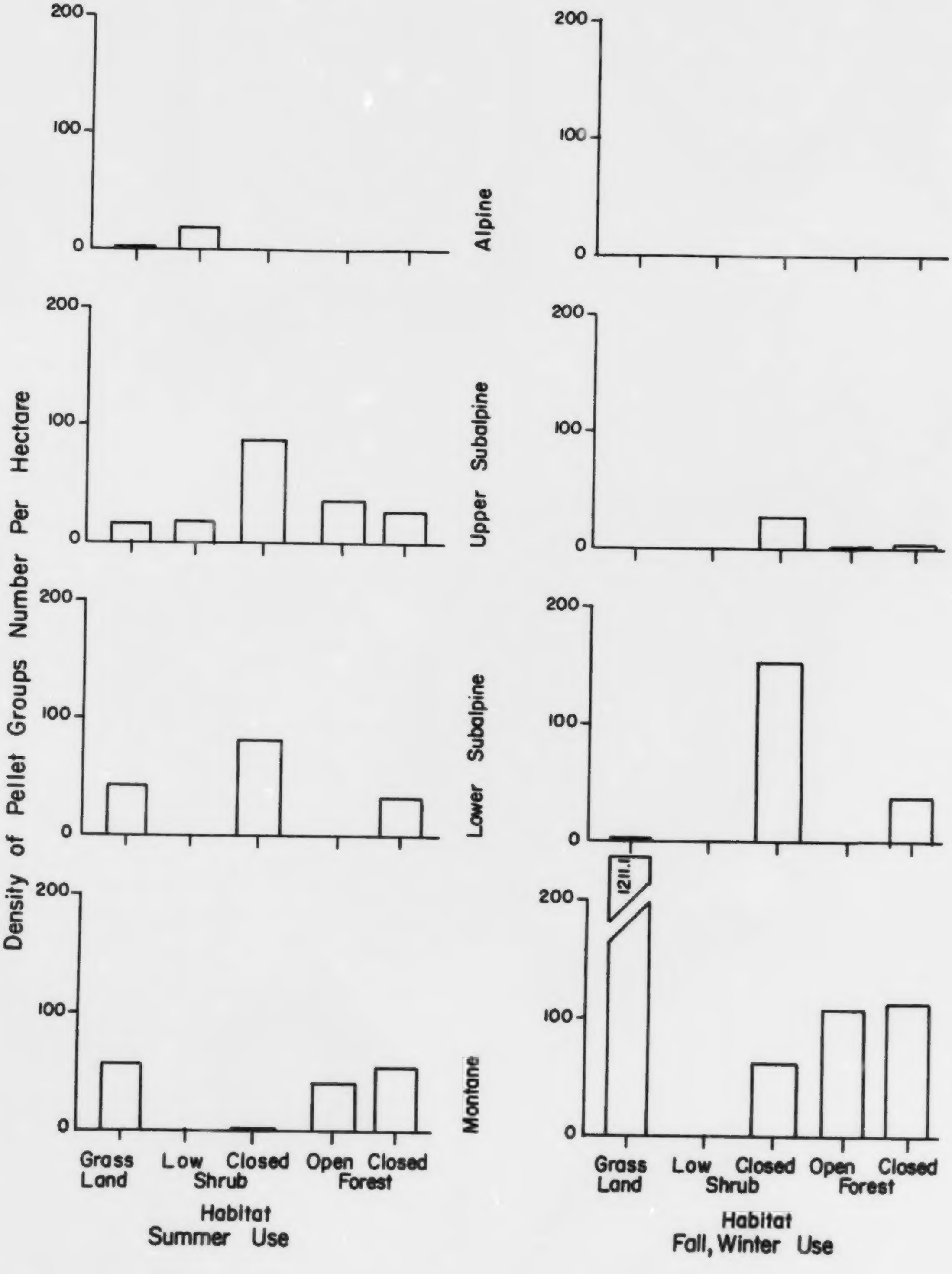

KOOTENAY NATIONAL PARK
Marble Canon
Vermilion River
Vermilion Crossing
Kootenay
6500
River
Simpson
Kootenay Crossing
Columbia
River
4200
River
Radium
ELK
◇ June, July, August
△ September, October, November
Contour Intervals
4200 ft. (1280 m)
6500 ft. (1981 m)
0 kilometres 5

Figure 4.10. Elk seasonal habitat use by Ecoregion in KNP from pellet count data.



slopes (FV5).

With the onset of winter and increased snow accumulation elk migrate from the Lower Subalpine slopes and valley bottoms in the Vermilion drainage to the Montane valley bottoms of the lower Vermilion and Kootenay rivers where snow accumulation is lowest. In winters of low snowfall elk are able to occupy a larger area, including lower slopes in the Lower Subalpine Ecoregion. Most winters however, they are confined to the Montane fluvial (FR, VL, HD) and glacial (DR, WT) Ecosections along the lower Vermilion and Kootenay rivers. High densities of winter pellets were recorded in Douglas fir, lodgepole pine and spruce forests with grassy understories and mixed poplar/coniferous forests (C1, C9, C16, C37, C44), and in grassland (H6, H19 and man-made grasslands), herb meadows (H8), willow-birch shrublands (S1) and spruce and sedge fens (O11, H11).

There were an average of 1.8 elk tracks/km-day on transects in the Montane Ecoregion but only 0.1 tracks/km-day in the Lower Subalpine Ecoregion. No elk tracks were recorded in the Upper Subalpine or Alpine. A similar high use of Montane Ecosites was recorded in BNP and JNP (Holroyd and Van Tighem 1983).

Snow depth is a major determinant of the extent of available winter range. The Kootenay valley between McLeod Meadows and Kootenay Crossing and the Wardle flats area of the lower Vermilion appear to receive less snow than surrounding areas. During the winters of 1981-82 and 1982-83, January snow depths exceeded 50 cm. in most Ecosites, and was as high as 80 cm. in some areas where elk were wintering. Snow measurements taken along Highway 93 in January and April 1982 showed that average snowdepths were about 10 cm. less in the area between McLeod Meadows and Kootenay Crossing and 20 cm. less through Wardle flats than elsewhere along the highway. On 19 April 1982 when snowdepths in the Kootenay valley were still 30 to 40 cm., the Wardle flats area had less than 10 cm and was 50 to 60% snow free.

The significance of the seeded right-of-way along Highway 93 as elk winter range is discussed in detail elsewhere (Section 3.7.). This artificial grassland provides a substantial amount of forage for wintering elk and is used heavily until late winter when snow depths exceed 50 cm. and snow crusts prevent cratering.

SPECIES ATTRIBUTES

Elk are able to adapt their foraging strategies to changes in forage availability and quality as affected by changing climatic factors and successional trends. In KNP, browse is the most heavily used year-round forage resource (see section 3.6), however grasses and sedges are exploited during spring, autumn and early winter.

The optimum winter diet for elk consists of a mixture of shrubs and grass-like plants. Protein in dormant twigs, although only a fraction of that available during the growing season, is sufficient to meet minimum requirements for effective rumen function. Protein in cured grasses is less than the minimal requirement, however they are a good source of energy which can be utilized if the rumen nitrogen is sufficient to ensure efficient digestive function (Hobbs *et al.* 1981). Therefore, a more or less balanced ratio of shrubs and graminoids in autumn, winter and spring ensures efficient digestive function. Lengthy imbalances in the ratio can impair condition of certain age-classes in the population (Trottier *et al.* 1983). Trottier *et al.* (1983) presents a model of seasonal elk diets in Riding Mountain National Park incorporating foraging-weather severity relationships.

Productivity of the KNP elk population as determined by the autumn ratio of calves/100 cows for the period 1952 to 1982 is shown in Table 4.10. The average productivity for the period 1973 to 1982 was 34.9 calves/100 cows. Average productivity of elk in BNP and JNP for the period 1975 to 1980 (September-November) was 18.2 and 30.4 calves/100 cows, respectively (Holroyd and Van Tighem 1983) .

Collisions with motor vehicles are the single most important causes of elk mortality in KNP. For the period 1951 to 1983 a total of 242 elk mortalities were recorded on park wildlife cards: 172 highway, 27 poaching, 14 predation, 10 destroyed by parks, and 17 unknown causes. Sheehan (1982) reported a 325% increase in highway mortality of wildlife in KNP between 1974 and 1981; there was a 45% increase in highway related elk mortalities. He reported a 16% increase in traffic volume during the same period. Since 1980 there have been an average of 26 elk killed per year on Highway 93 within the park.

MANAGEMENT CONSIDERATIONS

The Montane Ecoregion, particularly in the Kootenay valley, is of critical importance to elk wintering in the park. This area is also the major transportation corridor through the park and contains numerous tourist facilities. Recent increases in traffic volume, both tourist and commercial, have resulted in substantial increases in elk mortality and will continue to do so to the detriment of the population.

Habitat loss in the Montane Ecoregion, as a result of facility development and forest succession in the absence of fires, has reduced the carrying capacity for wintering elk. Elk are increasingly attracted to the seeded right-of-way along Highway 93 for forage during autumn, early winter and spring which has led to increased encounters with motor vehicles.

Close monitoring of elk numbers, mortality and winter range condition and trend is indicated as well as examining the mitigation measures discussed by Flygare (1979) and Damas and Smith (1982) and those being implemented currently in BNP.

MULE DEER *Odocoileus hemionus*

MULE

STATUS AND DISTRIBUTION

The mule deer is found from southeastern Manitoba to interior B.C., east of the Coast Range and north to the southern Yukon and southwestern Mackenzie District, NWT. Mule deer are common throughout southeastern B.C. Petticrew and Jackson (1980) estimated the population of the Kootenay Region to be approximately 15,000, comprising 4% of the provincial total.

In KNP mule deer were considered abundant in the Sinclair and Kootenay districts during the 1920's and early 1930's (warden files). Numbers declined through the 1940's and early 1950's possibly because of competition from a burgeoning elk population as well as several severe winters (1942-43, 1945-46, 1949-50, 1950-51). Cowan (1943) and Munro and Cowan (1944) found them to be less numerous than white-tailed deer and observed a scarcity of yearlings and general poor condition of deer, considering these indicative of poor herd condition. Warden Meredith estimated the park population to be approximately 150 in 1944. There are several records of supplemental feeding of mule deer and bighorn sheep at Radium during the hard winters of 1949-50 and 1950-51.

Although difficult to interpret due to frequent count duplication and the grouping of mule deer and white-tailed deer as "deer" in early summary reports (see white-tailed deer) the historic warden files indicate that mule deer recovered somewhat during the 1950's and were considered more numerous than white-tailed deer by 1956. Numbers of both deer species remained low relative to population estimates from the 1940's. Over the past 30 years the mule deer population has followed a similar trend to that of white-tailed deer, remaining higher than the latter. Both species declined during the 1960's, probably as a result of severe winters in 1961-62, 1962-63 and 1964-65; and both increased during the 1970's. Mule deer are currently more numerous than white-tailed deer with maximum unduplicated counts ranging from 25 to 30 each year since 1979 (park wildlife cards.

In summer and autumn mule deer are distributed along the main valleys of the Kootenay and Vermilion rivers from the south boundary to Vermilion Pass (Fig. 4.11) but most are concentrated in the Sinclair and Stoddart Cr. watersheds. Of 364 records of mule deer between June 1951 and May 1983, 175 (46%) were from the Sinclair-Stoddart area, 50 (14%) from the lower Kootenay watershed and 139 (40%) from the Vermilion watershed. A few records exist also from the Ochre, Tokumm and Verdant watersheds (park wildlife cards).

During winter many mule deer move beyond the west boundary of the park to the west and south aspects above the Columbia River. Those that remain in the park concentrate on the south and west facing lower slopes adjacent to Sinclair Cr. and its tributaries (*i.e.* John McKay Cr., Kimpton Cr., Redstreak Cr., and Kindersley Cr.)(Fig. 4.12). Winter track count transects revealed mule deer track counts of 13 tracks/km-days along Redstreak Cr., 3.2 tracks/km-days on John McKay Cr. and 0.4 tracks/km-days along the

Figure 4.11. Seasonal distribution of mule deer in KNP from park wildlife cards, 1978-1983

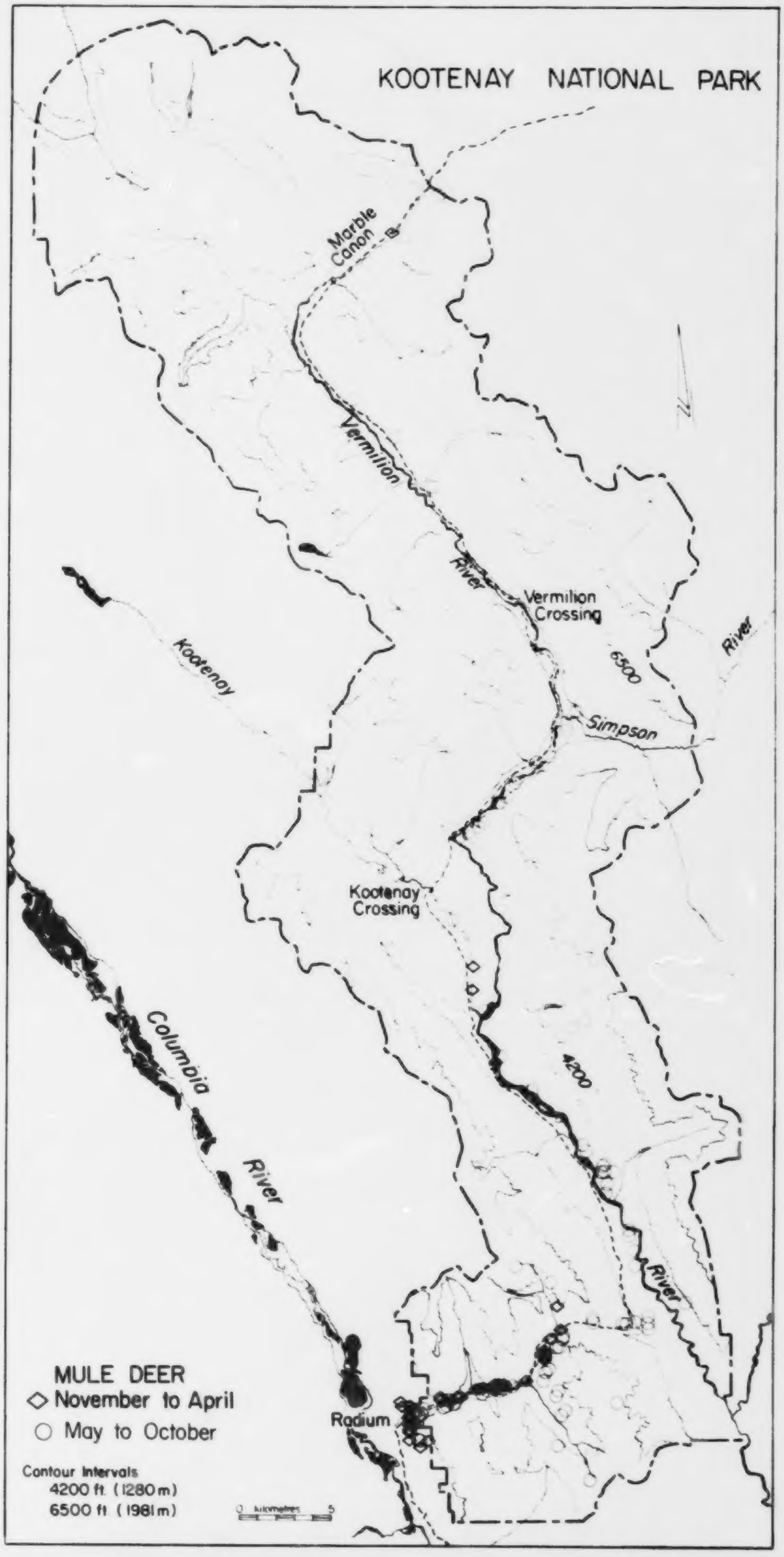
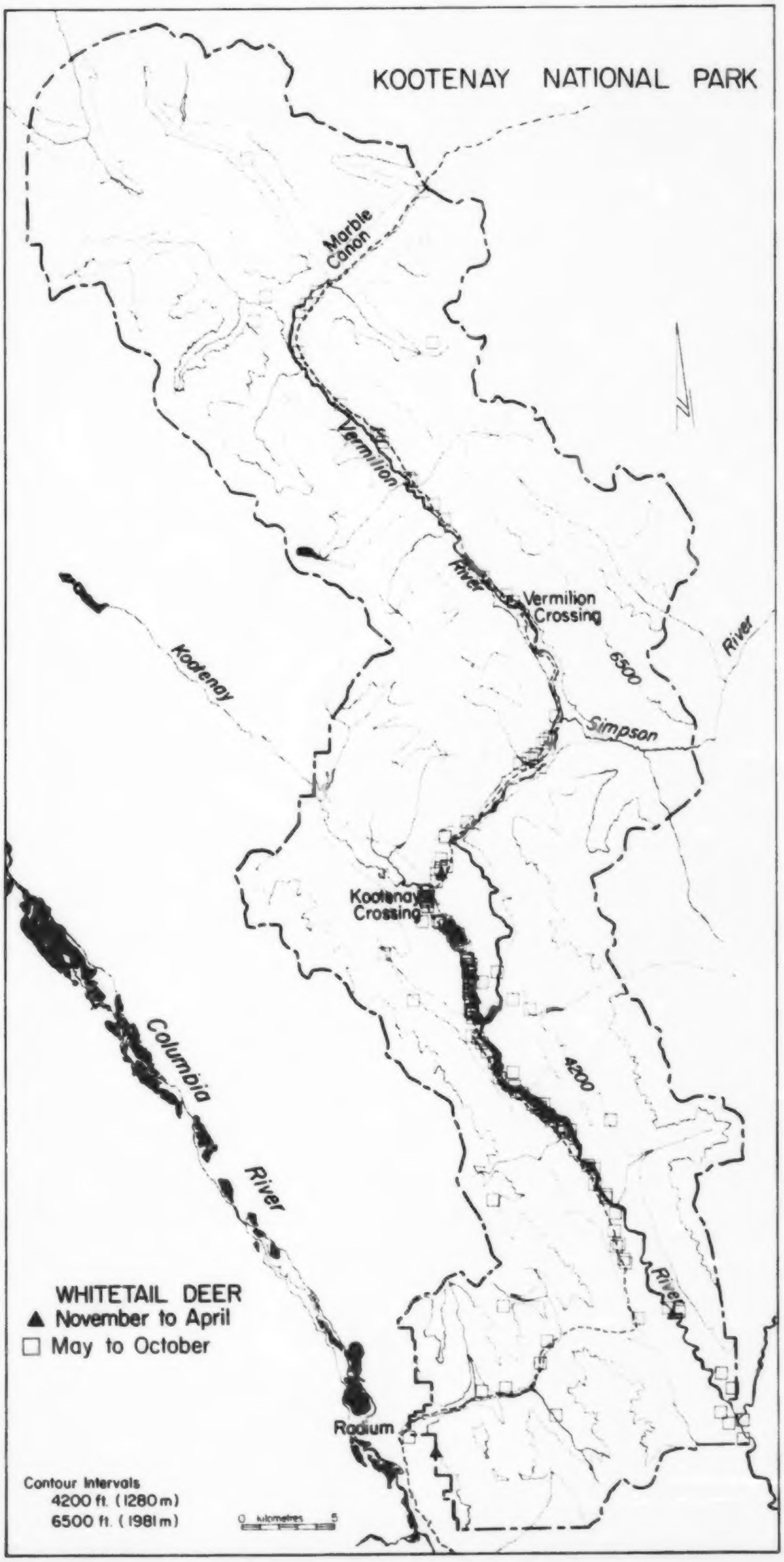

KOOTENAY NATIONAL PARK
Marble Canon
Vermilion River
Vermilion Crossing
6500
River
Simpson
Kootenay
Kootenay Crossing
Columbia River
4200
River
Radium
MULE DEER
◇ November to April
○ May to October
Contour Intervals
4200 ft. (1280 m)
6500 ft (1981 m)
0 kilometres 5
N

Figure 4.12. Seasonal distribution of white-tailed deer in KNP from park wildlife cards, 1978-1983


KOOTENAY NATIONAL PARK
Marble Canon
Vermilion River
Vermilion Crossing
6500
River
Simpson
Kootenay
Kootenay Crossing
4200
Columbia River
River
Radium
WHITETAIL DEER
▲ November to April
☐ May to October
Contour Intervals
4200 ft. (1280 m)
6500 ft. (1981 m)
0 kilometres 5

upper portion of Sinclair Cr. Track counts of 1.2 and 0.9 tracks/km-days were obtained on lower Stoddart Cr. in February 1982. Records of mule deer wintering elsewhere in the park are few. There are two records since 1951 of mule deer wintering in the lower Kootenay valley; one from December 1972 and one from February 1975. The only other reference to mule deer wintering in other areas comes from Munro and Cowan (1944) who mention that small numbers wintered in the Wardle flats area of the lower Vermilion in 1925.

HABITAT

The mule deer is primarily a species of Montane valley bottoms and lower slopes but during summer they range at all elevations, even occasionally to the Alpine Ecoregion. In contrast to white-tailed deer, which are restricted to Montane valley bottoms, mule deer use lower to mid-slope areas in the Montane and Lower Subalpine Ecoregions. Of 117 mule deer observations since 1978, 52% were in Montane valley bottoms, 36% on Montane lower slopes and 11% on Subalpine middle and upper slopes. Deer are most common in the Montane Ecoregion (Table 4.13).

In summer mule deer frequent slopes and embankments with open coniferous forest or dry grass and shrub meadows interspersed with patches of forest. Alluvial fans or glacial terraces with mixedwood, aspen and lodgepole pine forests are also favoured. Colluvial slopes with early-successional lodgepole pine vegetation in the Vermilion Pass burn also receive high summer use (Fig. 4.13; Tables 4.14, 4.15).

Winter habitat characteristics are similar to the summer except that mule deer are confined to south and west facing colluvial slopes and glacial terraces in the Montane and Lower Subalpine Ecoregions, where sun and wind maintain shallow snow. Mule deer tracks were seldom found in snow deeper than 40 cm. and densities were highest at depths of less than 15 cm. Open and closed forests of Douglas fir, lodgepole pine and white spruce with dry understories of grasses, rose and bearberry are heavily used. Mixedwood and mixed coniferous closed forests receive high use in the autumn and the open Douglas fir-grassland complex on west-facing glacial terraces and lower slopes in the Columbia valley receive high use in the winter (Table 4.15).

The use of open, south-facing slopes becomes most pronounced in March and April as these sites provide the earliest available sources of green vegetation. These Montane colluvial (DG1, DG3, DG6) and morainal (DR1, DR7, DR8) Ecosites are critical to mule deer at a time of year when fat reserves are most depleted. Specific areas of critical winter and spring mule deer habitat are the south and west-facing lower slopes above Sinclair, John McKay, Kimpton and Redstreak creeks, the glacial terraces and lower west-facing slopes in the Columbia valley and the south-facing colluvial slopes above Palmer, Dry Gulch and Stoddart creeks.

SPECIES ATTRIBUTES

Mule deer are highly diverse and opportunistic in their forage selection. In KNP shrubs are probably an important year-round source of forage, however forbs and grasses are important spring and summer food items. Key shrub taxa include; saskatoon, mountain maple, red-osier dogwood, willow, rose, meadowsweet and raspberry.

Collisions with motor vehicles are the chief causes of mule deer mortality reported in park wildlife cards between 1951 and 1983. Of 80 records of mule deer mortality during this period, 64 (80%) were road-kills, 9 (11%) were predation and 7 (9%) were other or unknown causes. Sixty percent of the road-kills occur on the highway along Sinclair Cr. during the winter and spring. Highway mortality of mule deer has averaged six per year since 1980 (Sheehan 1982, park wildlife cards).

MANAGEMENT CONSIDERATIONS

Maintenance of undisturbed habitats along the lower, south and west facing slopes above Sinclair, John McKay and Redstreak creeks and above the Columbia valley is crucial to wintering mule deer in KNP.

The lack of specific data on population size makes assessment of the impact of highway mortality on the mule deer population impossible. Further study of population size, dynamics and seasonal range use is indicated in order to properly assess the impact of highway mortality.

Table 4.13. Deer distribution by Ecoregion and season in KNP from pellet count transects.

Ecoregion	Spring to early summer	late summer, autumn and winter	All year
	Average pellet groups/ha		
Montane	29.4	109.6	139.0
Lower subalpine	8.5	26.1	34.6
Upper Subalpine	4.5	14.3	18.8
Alpine	0.0	0.0	0.0

WHITE-TAILED DEER ***Odocoileus virginianus*** **WHIT**

STATUS AND DISTRIBUTION

White-tailed deer are common across southern Canada from Cape Breton Island to southeastern B.C. In B.C. they are restricted to the southeast (Columbia and Kootenay regions) and the Peace River area. Although native to B.C., whitetails were probably less numerous before settlement and the resultant clearing of land (Petticrew and Jackson 1980). These authors estimate there to be approximately 16,000 whitetails in the Kootenay District, comprising 65% of the provincial population.

It appears that whitetails were abundant in KNP from the mid-1930's to the late 1940's. Munro and Cowan (1944) considered white-tailed deer, ... "one of the most abundant and characteristic animals of the Vermilion and Kootenay valleys". Warden Meredith estimated the population to be approximately 250 animals in 1944.

It is not possible to accurately interpret population figures prior to the 1950's for two reasons:

1. Many population figures reported in Warden Monthly Reports and Superintendants Annual Reports grouped white-tailed and mule deer as "deer".
2. Totals for each month were the sum of all animals seen in a district for that month regardless of duplication.

However misleading actual population figures are, whitetails underwent a sharp decline in the park during the early 1950's, similar to the elk population. No doubt the severe winters of 1949-50 and 1950-51 were contributing factors in conjunction with depleted range condition and extent through over-utilization by high ungulate populations and natural forest succession. In 1956 it was noted that whitetails were less numerous than mule deer which was a reverse in trend from the 1940's.

By 1963 there were estimated to be 100 whitetails in the park in summer however, maximum single counts were less than 30 animals in 1963 and 1964. Numbers declined again after 1963-64 and have remained low, relative to the 1940's and 1950's, until the present. Numbers increased slightly during the mid 1970's. A maximum unduplicated count of 21 whitetails was obtained in November 1975. With the exception of 1972 and 1975, over the past 20 years the maximum number of white-tailed deer observed on single surveys in the Kootenay and Vermilion valleys during the summer has averaged less than 15 animals.

The distribution of white-tailed deer in KNP is confined to riparian habitats along the Kootenay and Vermilion rivers (Fig. 4.11). Munro and Cowan (1944) observed whitetails in summer throughout the length of the main valleys from Settler's Road to Vermilion Pass and noted tracks at least nine miles up Tokumm Cr. The present summer distribution is much the same, however, as in the past, whitetails are concentrated during summer in the lower Kootenay valley between Settler's Road and Kootenay Crossing. Of 401 observations of

Figure 4.13. Deer seasonal habitat use by Ecoregion in KNP from pellet count data.

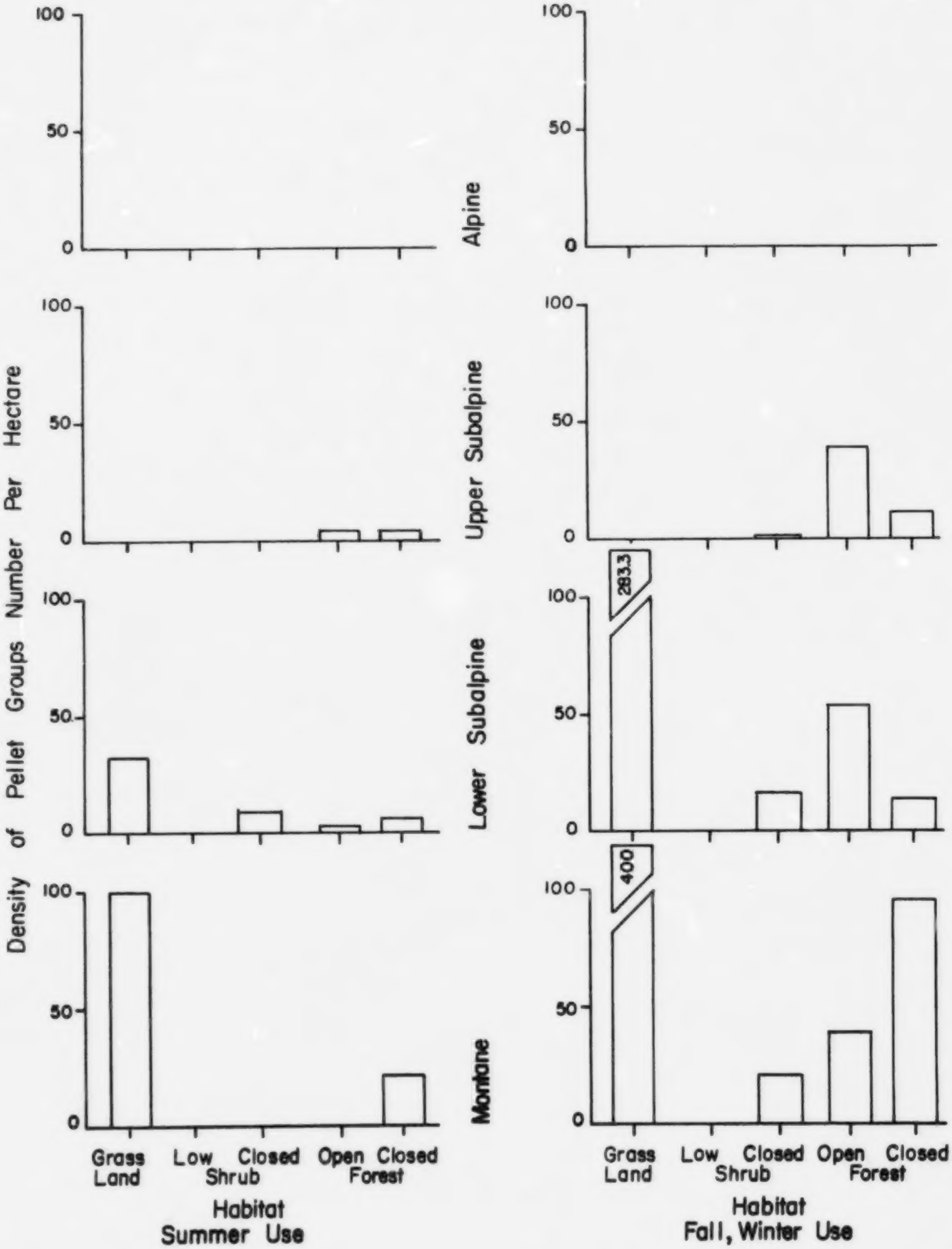


Table 4.14. Highly important Ecosites for deer in KNP based on pellet group counts.

Ecosite	Pellet groups /ha	Ecoregion	Landform	Vegetation
Spring and early summer				
BY7B	83.3	L. Subalpine	glacial	lodgepole pine burn
DG1	56.7	Montane	colluvial	Douglas fir forest
DR1	55.0	Montane	morainal	Douglas fir forest
DR7	71.4	Montane	morainal	lodgepole pine forest
DR8	116.7	Montane	morainal	lodgepole pine; shrub meadow
HD3	33.3	Montane	fluvial	white spruce, mixedwood
HD6	55.0	Montane	fluvial	herb mat
WF5	30.0	U. Subalpine	colluvial	spruce-fir
Late summer, autumn and winter				
DG1	210.0	Montane	colluvial	Douglas fir
DG3	158.8	Montane	colluvial	open Douglas fir
DG6	100.0	Montane	colluvial	lodgepole pine
DR1	225.0	Montane	morainal	Douglas fir
DR2	81.3	Montane	morainal	lodgepole pine
DR4	75.0	Montane	morainal	aspen, mixedwood
FR3	132.1	Montane	fluvial	white spruce, mixedwood
HD3	100.0	Montane	fluvial	white spruce, mixedwood
HD6	350.0	Montane	fluvial	herb mat
SB3	80.0	L. Subalpine	colluvial	lodgepole pine
SB4	150.0	L. Subalpine	colluvial	open mixed coniferous
SB7	187.5	L. Subalpine	colluvial	lodgepole pine
WF3	100.0	U. Subalpine	coll. & rock	open mixed coniferous
WY1	300.0	Montane	glacial	Douglas fir
WY2	357.1	Montane	glacial	open Douglas fir, grassland

whitetails since 1951, 63% were from the lower Kootenay valley, 25% from the Vermilion valley, 10% from the Sinclair and Stoddart Cr. drainages and the remainder from the upper Kootenay, Ochre and Tokumm Cr. drainages.

In most years whitetails migrate out of the park southwards into the Kootenay valley or west into the Columbia valley. There are very few records since the 1940's of whitetails wintering in the Kootenay valley. Munro and Cowan (1944) mentioned that small herds of white-tailed deer wintered in the vicinity of ASW camps in the lower Kootenay valley in 1941-42 and 1942-43 where workers were engaged in cutting beetle-killed pine. The deer fed on lichens (*Usnea*) from fallen tree limbs. Other records of wintering whitetails, all of single animals, were from 1956, 1958, 1964, 1972, 1979 and 1980. Whitetails are more frequently observed during winter in the Sinclair and Stoddart Cr. drainages within the park, in the Columbia valley (Fig. 4.12).

HABITAT

In KNP white-tailed deer occur on valley bottom fluvial and morainal Ecosites along the Kootenay and lower Vermilion rivers. Whitetails are rarely observed above the valley bottoms: of 132 warden records

Table 4.15. Highly important vegetation types for deer in KNP from pellet group counts.

Vegetation type	Pellet groups /ha	Description
Spring and early summer		
C1	44.1	Douglas fir/hairy wild rye
C5	29.2	white spruce-Douglas fir/feathermoss
C25	33.3	Engelmann spruce-subalpine fir/green alder
C38	66.1	lodgepole pine/buffaloberry/pine grass
C39	23.5	lodgepole pine/buffaloberry/bunchberry
C44	27.8	spruce-aspen-pine-(paperbirch)/buffaloberry/pinegrass
H8	100.0	yellow dryad-willow herb
H19	58.3	bluebunch wheatgrass-hairy wild rye-showy aster
O19	75.0	Engelmann spruce-subalpine fir/mountain avens
S5	27.8	lodgepole pine/twinflower-fireweed
Late summer, autumn and winter		
C1	283.3	Douglas fir/hairy wild rye
C5	300.0	White spruce-Douglas fir/feathermoss
C6	81.3	lodgepole pine/buffaloberry/showy aster
C16	75.0	aspen/hairy wild rye-peavine
C44	175.0	spruce-aspen-pine-(paper birch)/buffaloberry/pine grass
C45	75.0	white spruce-western larch-Douglas fir/bunchberry
H19	575.0	bluebunch wheatgrass-hairy wild rye-showy aster
H8	800.0	yellow dryad-willow herb
O4	138.9	Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine
O5	118.8	Douglas fir/Juniper/bearberry
O19	150.0	Englemann spruce-subalpine fir/mountain avens

since 1979, 112 (85%) were from valley bottom and 20 (25%) were from lower slope areas primarily in the lower Kootenay watershed, and largely below 1200 m. The preference for Montane valley bottom habitats by whitetails as opposed to mule deer is further demonstrated by the results of roadside surveys conducted from 11 May 1981 to 20 May 1982 (see Section 3.7). In 50 surveys conducted between Settler's Road and Marble Canyon there were 64 observations of white-tailed deer and only 19 observations of mule deer.

The analysis of roadside surveys for habitat selection during the period May to July (Table DMP54) indicates a strong selection by whitetails for fluvial Ecosites (FR1, FR3, AT4, AT1) with white spruce (C37) mixedwood (C44) or lodgepole pine (C38) forests, and morainal Ecosites (DR2, DR8) with lodgepole pine (C38). Selection was greatest for associations of Ecosites such as FR3-AT4 and DR2-DR8. All Ecosites are associated with the seeded right-of-way of Highway 93.

Deer pellet groups cannot be reliably separated by species, however, in light of the preference of white-tailed deer for montane valley bottom and lower slope areas it is likely that most of the summer and fall deer use of montane fluvial (FR3, HD3, HD6) and morainal (DR1, DR4, DR8, DR7) Ecosites in the Kootenay valley is by white-tailed deer (Tables 4.14, 4.15). The most important summer and autumn vegetation types for whitetails from pellet group data (Table 4.15) are mesic pine forests(C38, C39, C6), mixed wood forests (C44) and aspen forests (C16) with grassy understories and are most heavily used when in association with yellow dryad-willow herb (H8) floodplain communities and disturbed sites such as road allowances, old gravel pits and man-made meadows where edge habitats are prevalent.

SPECIES ATTRIBUTES

Like other cervids white-tailed deer are opportunistic feeders, selecting forage which is most available and nutritious in a given season. Trottier *et al.* (1983) found that shrubs comprised over 90% of whitetail diets at all seasons except autumn when forbs comprised up to 26% of the diet. Major forb species included vetches, cinquefoil and composites. Important shrubs were beaked hazel, willows, poplar, raspberry and rose. In KNP important shrub species include saskatoon, willow, red-osier dogwood, mountain maple and rose.

As is the case in BNP and JNP (Holroyd and Van Tighem 1983) , probably the most significant mortality factor for whitetails in KNP is the automobile. Of 77 records of whitetail mortality in KNP since 1951, 70 were highway mortalities. Predation accounted for five records and three mortalities were of unknown cause (park wildlife cards). Since 1980 an average of nine white-tailed deer were killed each year on the highway (Sheehan 1982, park wildlife cards).

MANAGEMENT CONSIDERATIONS

White-tailed deer are the least numerous ungulate in the park and their distribution is restricted to Montane riparian habitats of the Kootenay and Vermilion valleys during, spring, summer and autumn. As these habitats are closely associated with the highway corridor whitetails are almost continuously exposed to highway traffic and may suffer most from increases in traffic volume. Close monitoring of population and highway mortality trends is indicated as well as identification of areas of deertraffic conflicts and possible implementation of control measures such as reduced speed limits, fencing or altered highway design in order to reduce mortality.

MOOSE *Alces alces*

MOOS

STATUS AND DISTRIBUTION

The moose is a circumpolar species occupying the coniferous forest regions of North America, Asia and Europe. In Canada it occurs throughout the boreal forest region, the Rocky Mountains and the interior and coastal regions of B.C. In British Columbia, moose are widely distributed throughout the province, however such has not always been the case. Prior to 1860 moose were restricted to the northern boreal forest regions and the extreme southeastern portion of the province, south of Crowsnest Pass (Petticrew and Munro 1979). Only in this century have moose invaded most of southern B.C. as a result of clearing and burning of forested land for settlement, agriculture and logging. Moose reached peak numbers in B.C. during the mid-1950's and mid-1960's then declined through to the early 1970's as a result of habitat loss and increased hunting pressure. In 1977 there were estimated to be 3500 moose in the Kootenay District which comprised only two percent of the total provincial population (Petticrew and Munro 1979).

Moose have been present in KNP since its inception in 1920, and of all the cervids present has probably undergone the most dramatic fluctuations in abundance, as a result of changes in habitat quality and quantity as influenced by fire and forest succession. Records from early park files indicate that moose were relatively common in the early 1920's, but underwent a dramatic increase in numbers from the late 1920's to late 1930's, no doubt in response to an increase in habitat resulting from the 1926 burn in the upper Kootenay and lower Vermilion valleys. By 1933-34 there were estimates of over 300 moose in the Kootenay District and up to 200 in the Marble Canyon District during summer. Numbers apparently peaked in the late 1930's and declined steadily throughout the 1940's. Warden reports for 1939 indicated moose were decreasing and in April 1941 moose were reported in poor condition with heavy tick infestations. They were sufficiently numerous in 1943 to be considered by Munro and Cowan (1944) as the most widely distributed and with the exception of elk, the most abundant game animal in KNP. Counts of moose declined steadily throughout the 1940's and took a sharp drop following the severe winters of 1949-50 and 1950-51 with numbers reported from three Warden Districts dropping from 54 in 1949 to 14 in 1951. The maximum number reported during 1951 was 14.

Park wildlife cards indicate that moose reached lowest numbers during the 1960's. Although they remained widely distributed, observations were infrequent and none were seen on several game censuses during this period. In 1963 Warden J. Holroyd estimated the total park population to be 60-75 animals, although the maximum number reported during 1963 was only eight. By 1965 the population was estimated at thirty, based on a maximum count of nine. Regardless of the actual numbers, it is obvious that moose, like the other cervid populations in KNP underwent a rapid increase in numbers during the 1920's and 1930's in response to an abundance of early successional habitats produced by fires in 1917 and 1926. Overstocking of ranges and continued forest maturation in the absence of fires coupled with several severe winters led to dramatic declines of all ungulate populations, but particularly of moose during the 1940's and 1950's. Moose numbers improved slightly by the late-1960's and have remained relatively stable to the present. Maximum unduplicated counts from park wildlife cards between 1980 and 1982 averaged 21 animals. It is likely that there are fewer than 75 animals currently inhabiting the park.

Although moose numbers have fluctuated widely since 1920, their distribution within KNP has changed little. Moose occupy the valley bottoms and lower slopes of all major watersheds within the park (Fig. 4.14). Concentrations occur in the Vermilion valley and lower Kootenay valley. Moose or their sign were recorded in 10 of 11 watersheds during this inventory with most records coming from the upper and lower Vermilion and Kootenay watersheds. The Stoddart Cr. area was the only watershed in which moose were not recorded although they have been recorded there in the past. On winter track count transects highest densities occurred in the upper Kootenay (0.98 tracks/km-day) and upper Vermilion (0.49 tracks/km-day) watersheds. Aside from the main valleys of the Vermilion and Kootenay rivers, wintering moose were recorded along Redstreak, Swede, Pitts, Daer, Verendrye, Tokumm and Verdant creeks. The only areas where moose appear not to over-winter are the upper Ochre, upper Ottertail and upper Tokumm drainages where snow depths routinely exceed 100 cm.

HABITAT

Although generally considered a coniferous forest species, moose tend to avoid climax coniferous forests in favor of subclimax shrubby habitats and deciduous forests created through processes which inhibit or set back plant succession such as water erosion, avalanching, cold air drainage and fire. Peterson (1955) states that ".... moose populations apparently reach their maximum in the early stages of succession and decrease as the forest reaches maturity".

The most important year-round moose habitats in KNP are those with a combination of suitable cover and high browse production (Tables 4.16, 4.17; Fig. 4.15). These include Ecosites on fluvial landforms (AL3, AT4, HC1, HD3, VL2) with wetlands (O11) and riparian spruce (C37, C41) and mixed forests (C44) and glacial landforms (CA1, CA2, DR6, DR8) with a wet-dry pattern of closed coniferous forest (C37, C38, C14, C25), open spruce fen (O11, O14) and wet shrub meadows (S1, H11). Moose also make heavy use year-round of Montane and Lower Subalpine colluvial Ecosites (DG6, SB1, FV5, FV6) with avalanche shrub (S8, S13) or open mixed wood slopes (C44) as well as fluvial and colluvial Ecosites (BV2B, SB3B) in the Vermilion Pass burn with early-successional lodgepole pine-shrub vegetation (S5).

In winter, moose take advantage of microhabitats along the lower reaches of many of the small side valleys emptying into the main valleys of the Vermilion and Kootenay rivers. Here they make heavy use of the riparian shrub communities bordering the stream courses where snow conditions are more favourable to movement than in the adjacent closed forested areas. In the Kootenay valley the DR5 Ecosites on the lower reaches of many tributary streams receive high use by moose in winter.. Similar conditions exist in many of the tributary streams in the Vermilion valley and moose regularly wander along the lower reaches of Wardle, Verendrye, Floe, Numa and Tumbling creeks as well as in Verdant Cr.

Habitat selection by moose varies little between summer and winter but there is a shift to lower elevation habitats in winter. In summer, moose are more abundant in Lower Subalpine and Upper Subalpine habitats than in the Montane while in winter they are most numerous in the Montane and Lower Subalpine (Table 4.18). This shift to lower elevation habitats in winter is a response to the greater abundance of woody browse material in the Montane and Lower Subalpine valley bottoms rather than a factor of snow depth. Snow conditions are only a factor for moose wintering in the side valleys of the Vermilion as they are forced to seek out the more favorable snow conditions along the stream channels. Winter track transects showed moose activity highest at snow depths between 56 and 80 cm. however moose tracks were recorded at snow depths of 120 cm (Table 4.19). Where moose wintered in the Lower Subalpine along Verendrye and Verdant creeks snow depths averaged 96 cm. and went as high as 120 cm.

Figure 4.14. Seasonal distribution of moose in KNP from park wildlife cards, 1978-1983.

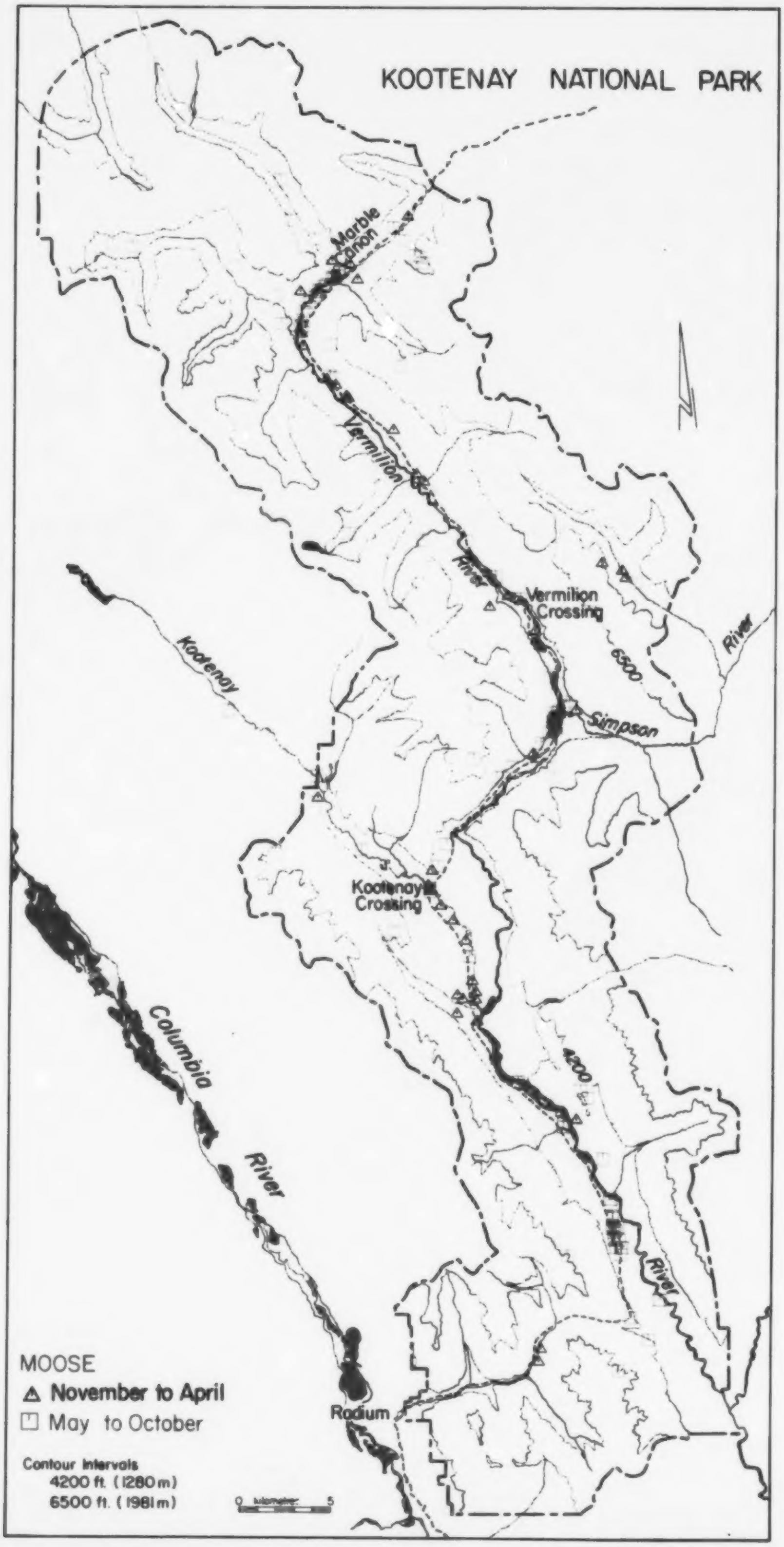

KOOTENAY NATIONAL PARK
Marble Canyon
Vermilion
River
Vermilion Crossing
6500
River
Simpson
Kootenay
Kootenay Crossing
Columbia
River
4200
River
Radium
MOOSE
△ November to April
☐ May to October
Contour intervals
4200 ft. (1280 m)
6500 ft. (1981 m)
0 kilometer 5

Table 4.16. Highly important Ecosites for moose in KNP based on pellet group counts.

Ecosite	Pellet groups /ha	Ecoregion	Landform	Vegetation
Spring and early summer				
AL3	22.2	L. Subalpine	fluvial	spruce-fir
BV2B	50.0	L. Subalpine	glaciofluvial	lodgepole pine burn
HC1	33.3	L. Subalpine	fluvial	open spruce-fir
PL6	30.0	L. Subalpine	morainal	spruce-fir
SB3B	33.3	L. Subalpine	colluvial	lodgepole pine burn
Late summer, autumn and winter				
AL3	55.6	L. Subalpine	fluvial	spruce-fir
AT4	75.0	Montane	glaciofluvial	white spruce
BV2B	50.0	L. Subalpine	glaciofluvial	lodgepole pine burn
CA2	78.6	L. Subalpine	morainal	spruce-fir
DG6	90.0	Montane	colluvial	lodgepole pine/buffaloberry
DR5	225.0	Montane	glacial	spruce-Douglas fir
HD3	50.0	Montane	fluvial	spruce, mixed wood
SB1	66.7	L. Subalpine	colluvial	avalanche complex > spruce-fir
VL2	50.0	Montane	fluvial	wet shrub meadow

Table 4.17. Highly important vegetation types for moose in KNP from pellet group counts.

Vegetation type	Pellet groups /ha	Description
Spring and early summer		
C14	6.6	Engelmann spruce-subalpine fir/false azalea
C15	11.1	Engelmann spruce-subalpine fir/grouseberry
C44	5.6	Spruce-aspen-pine-(paperbirch)/buffaloberry/pinegrass
O5	12.5	Douglas fir/juniper/bearberry
S5	16.7	lodgepole pine/twinflower-fireweed
Late summer, autumn and winter		
C5	70.8	white spruce-Douglas fir/feathermoss
C14	29.5	Engelmann spruce-subalpine fir/false azalea
C25	33.3	Engelmann spruce-subalpine fir/green alder
C37	25.0	white spruce/buffaloberry/feathermoss
C41	50.0	white spruce-subalpine fir/bunchberry-horsetail
C44	61.1	spruce-aspen-pine-(paperbirch)/buffaloberry/pinegrass
C45	50.0	white spruce-western larch-Douglas fir/bunchberry
S1	50.0	dwarf birch-shrubby cinquefoil-willow/brown moss
S8	150.0	willow/cinquefoil

Table 4.18. Seasonal distribution of moose by Ecoregion from pellet group counts and winter track counts.

Ecoregion	*Average pellet groups / ha*			*Tracks/km-day*
	Spring, early summer	Late summer, autumn and winter	All year	
Montane	0.6	31.9	32.5	0.28
Lower Subalpine	3.4	20.1	23.5	0.30
Upper Subalpine	2.2	2.7	4.9	0.00
Alpine	0.0	0.0	0.0	0.00

Table 4.19. Moose activity at various snow depths in KNP from winter track transects.

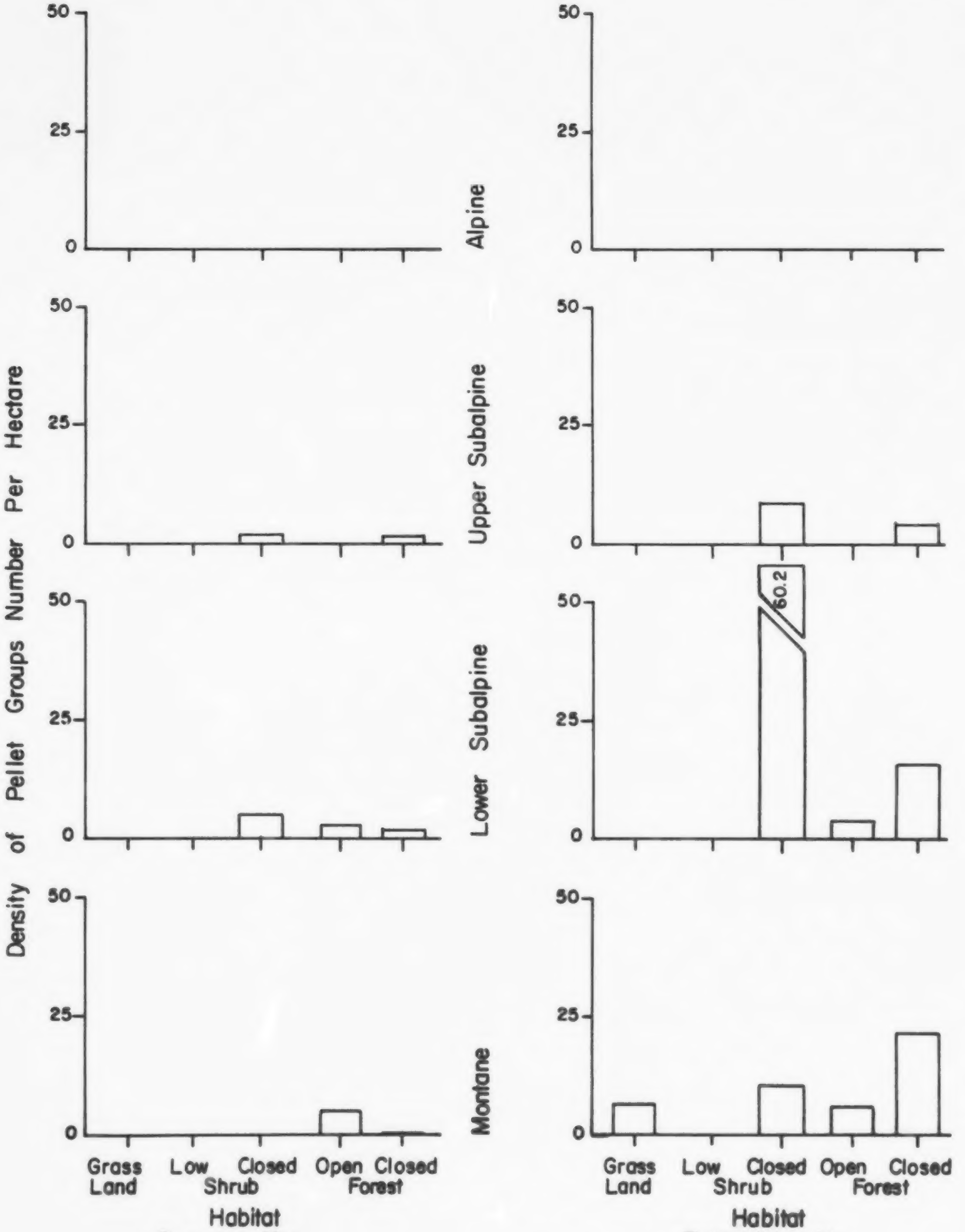
Snow depth (cm)	# transects	Tracks/km-day
21-25	1	1.25
26-30	-	
31-35	1	0.03
36-40	2	0.41
41-45	-	
46-50	1	0.11
51-55	-	
56-60	6	0.44
61-65	4	0.71
66-70	8	0.67
71-75	-	
76-80	3	0.46
81-85	-	
86-90	4	0.56
91-95	1	0.24
96-100	2	0.15

SPECIES ATTRIBUTES

Moose are predominantly browsers, year-round, relying on a relatively low number of shrub species for sustenance. Trottier *et al.* (1983) found that shrubs comprised greater than 95% of moose diets in all seasons except autumn when sedges comprised up to 12% of the diet. In KNP, key browse species for moose include willows, poplar, saskatoon, false azalea and rhododendron.

The major source of moose mortality recorded on park wildlife cards since 1951 is collisions with motor vehicles. Of 29 records of moose mortality, 19 (65%) were caused by vehicles. A further four mortalities were animals destroyed because of injuries, likely sustained in vehicle collisions. Of the remaining six mortalities recorded, five were of unknown cause and one was predation by a grizzly.

Figure 4.15. Moose seasonal habitat use by Ecoregion in KNP from pellet count data.



MANAGEMENT CONSIDERATIONS

In as much as many of the favoured winter habitats of moose in KNP such as avalanche slopes, fluvial wetlands and stream banks are maintained in early successional stages by natural processes, the future of moose in the park is relatively secure. However, it is evident that moose numbers have declined substantially from former years, particularly in the Kootenay valley, as a result of advancing forest succession in the absence of fires. The current importance of the Vermilion Pass burn to moose illustrates the importance of fire in providing moose habitat.

Many of the side valleys draining into the Vermilion and Kootenay valleys are key wintering areas for moose. Care should be taken in placement of cross-country ski trails to avoid use of these stream channels and adjacent banks to reduce human disturbance for moose during the critical late winter and early spring periods.

MOUNTAIN GOAT *Oreamnos americanus* GOAT

STATUS AND DISTRIBUTION

Mountain goats are restricted to the mountainous regions of northwestern North America from southeastern Alaska, Yukon and NWT to southcentral Washington and central Idaho. B.C. has more goat range than any other area of North America and supports the largest goat population in the world (Johnson 1977). Mountain goats are found throughout the mountainous regions of B.C. except for Vancouver Island and the Queen Charlotte Islands. Since the mid-1960's goat populations in B.C. have declined dramatically, primarily as a result of overharvesting (Petticrew and Munro 1977). In 1977 the estimated goat population of the Kootenay District of southeastern B.C. was 5000 animals, 11% of the provincial total (Petticrew and Munro 1977).

Mountain goats are widespread and common in KNP. Although this species is less frequently observed than other ungulates in summer it is second in number only to elk and in the winter it is the most numerous. Historic accounts of goats in KNP are scant prior to 1940 and much of the research effort since then has been centred on the population on Mt. Wardle which supports the largest and most visible concentration of goats in the park. This unique population has been studied in detail by Holroyd (1967), DeBock (1970) and in the present inventory (Section 3.8).

Estimates of total goat numbers in KNP declined between the 1930's and 1960's: there were an estimated 580 goats in the park in 1934; 300 in 1944 and 200 in 1964. There is no evidence to suggest that goats suffered a significant decline between the 1930's and 1940's, however population figures from Mt. Wardle indicate goats declined in the late 1940's and 1950's, probably as a result of the series of severe winters during the period. The Mt. Wardle population recovered during the 1960's and has remained relatively constant since then (Table 4.20). Current estimates from aerial surveys by the warden service in 1978 (Gibbons 1978) and 1983 (Sheehan 1983) place the park population at 300+ goats (Table 4.21).

Goats are found on all the mountain ranges within the park (Fig. 4.16, Table 4.21). Highest numbers occur in the Main Ranges, specifically the Mt. Wardle-Mt. Verendrye complex (Vermilion Range) and Hawk Ridge and Mt. Hafner (Ball Range). The Western Ranges have generally fewer goats but concentrations occur on Mt. Sinclair (Stanford Range) (Gibbons 1978; Sheehan 1983).

HABITAT

The mountain goat is a species that occurs predominantly in the Upper Subalpine and Alpine Ecoregions inhabiting herb and low shrub meadows and open coniferous forests in conjunction with rock bluffs and cliffs (Fig. 4.17). With the exception of the Mt. Wardle population (see Section 3.8) goats make much higher use year-round of Alpine and Upper Subalpine Ecosites than Lower Subalpine and Montane Ecosites. They show a slightly higher use of Upper Subalpine Ecosites than Alpine Ecosites in winter while the reverse is true in summer (Table 4.22). Goat use of the Alpine is highest in the Main Ranges at all times of the year because there are proportionally more Alpine Ecosites in the Main Ranges (Vermilion, Bow and Ball ranges) than in the Western Ranges (Brisco, Stanford and Mitchell ranges). Use of Montane and Lower

Figure 4.16. Mountain goat distribution in KNP from park wildlife cards, 1978-1982.

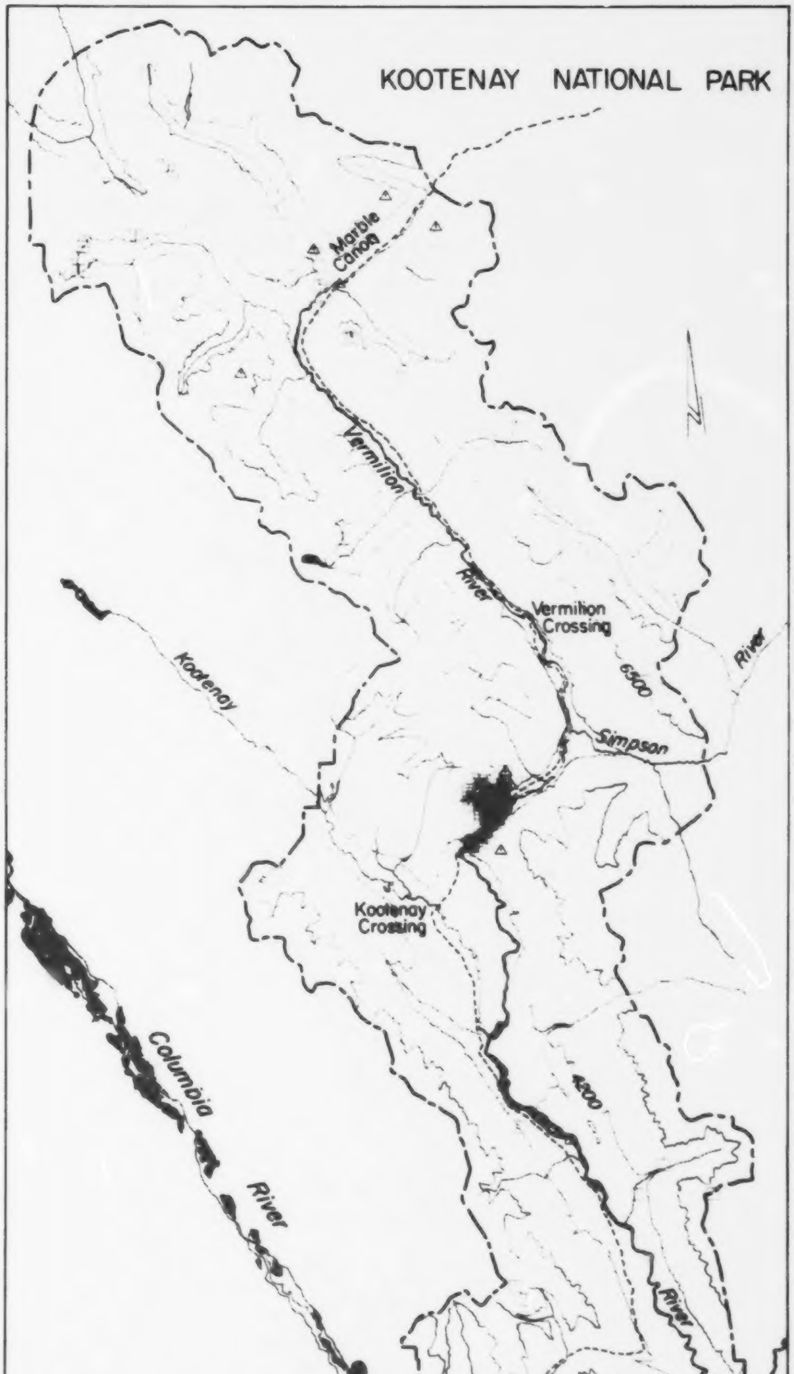

KOOTENAY NATIONAL PARK
Marble Canon
Vermilion
River
Vermilion Crossing
6500
River
Kootenay
Simpson
Kootenay Crossing
Columbia
River
4200
River
Radium
MOUNTAIN GOAT
△ November to April
☐ May to October
Contour Intervals
4200 ft. (1280 m)
6500 ft. (1981 m)
0 kilometres 5

Table 4.20. Mountain goat counts on Mt. Wardle, 1951-1982, from park wildlife cards.

Year	# records	Max count	Max # YOY	Min # >1 yr	Percent YOY
1951	3	23	2	21	9.5
1952	3	9	-	-	-
1953	1	8	-	-	-
1954	7	30	2	28	7.1
1955	-	36	-	-	-
1956	2	16	-	-	-
1957	1	5	-	-	-
1958	3	7	-	-	-
1959	4	14	5	9	55.6
1960	2	27	8	19	-
1961	0	-	-	-	-
1962	13	50	13	37	35.1
1963	54	69[1]	18	51	35.3
1964	11	64	13	51	25.5
1965	-	28[2]	-	-	-
1966	1	16	-	-	-
1967	-	94[3]	19	75	25.3
1968	-	118[3]	21	97	21.7
1969	16	70	21	49	42.9
1970	8	49	6	43	13.9
1971	17	13	3	10	30.0
1972	25	42	17	25	68.0
1973	27	36	8	28	28.6
1974	15	38	7	31	22.6
1975	24	37	7	30	23.3
1976	20	32	9	23	39.1
1977	12	33	6	27	22.2
1978	4	57[4]	14	43	32.6
1979	5	37	6	31	19.4
1980	5	24	5	19	26.3
1981	13	59	6	53	11.3
1982	22	59[5]	16	43	37.2
Means		38.5	9.7		27.5

[1] from Holroyd 1967
[2] from Annual Wildlife Report, Kootenay National Park 1965
[3] from DeBock 1968
[4] from Gibbons 1978, Aerial Survey
[5] present study

Subalpine Ecoregions is almost exclusively confined to the southfacing slopes and mineral lick of Mt. Wardle.

On an Ecosite basis there is little difference in goat habitat selection seasonally. The most heavily used Ecosites are steep colluvial slopes with mosaics of low shrub and herb meadow communities interspersed with rock outcrops and cliffs. An essential feature of all goat habitat is the proximity of foraging areas to rocky escape terrain. Goats rarely stray far from cliff areas except when travelling to licks when it is often necessary to traverse areas of closed forest.

Table 4.21. Numbers of mountain goats in KNP from autumn aerial surveys in 1978 (after Gibbons 1978) and 1983 (after Sheehan 1983).

Mountain Range	**Mountain goats observed**	
	1978	1983
Stanford Range	56	45
Brisco Range	10	12
Mitchell Range	17	17
Vermilion Range*	88	133
Ball Range	42	60
Bow Range	18*	33
Total:	231	300

*Gibbons 1978 included Bow Range (Prospector's Valley, Mt. Whymper and Scott's Peak) with Vermilion Range

Table 4.22. Seasonal distribution of mountain goats by Ecoregion in KNP from pellet group counts.

	Average pellet groups/ha		
Ecoregion	Spring and early summer	Late summer, autumn and winter	All year
Montane	1.1	0.6	1.7
Lower Subalpine	0.4	0.9	1.3
Upper Subalpine	31.8	29.1	60.9
Alpine	81.6	23.7	105.3

In winter, goats seek out areas where factors of slope and aspect act to reduce snow accumulation. In the case of the Mt. Wardle population this is accomplished by migrating to lower elevation (Lower Subalpine and Montane) south facing slopes (SB4, DG3) characterized by exposed rock bluffs and cliffs interspersed with avalanche paths (S16) and open coniferous forest (O4, O5). Other populations do not migrate to lower elevations, but seek out local areas in the Upper Subalpine and Alpine where the action of wind, sun and avalanching keep vegetation relatively snow-free (Tables 4.23, 4.24). Such areas include south to west facing steep slopes (RD2, WF2, WF3, WF6, WH4) and ridge crests (HE2) with patterns of alpine tundra, (H1,H2) low shrub (L7) and open krummholz forests (O4, O10, O14, O19) interspersed with broken cliffs and avalanche paths.

In summer, goats range more widely than in winter. Highest summer pellet densities were recorded in Alpine Ecosites (BS2, HE2) with avens tundra (H1) and herb tundra (H2) vegetation. High summer use was also recorded on Upper Subalpine colluvial slopes (WF2, WF6, WH7) with open and closed spruce-fir or larch-fir forests (C15, C21, C23, O10, O19) interspersed with avalanche paths or broken, rocky colluvial slopes

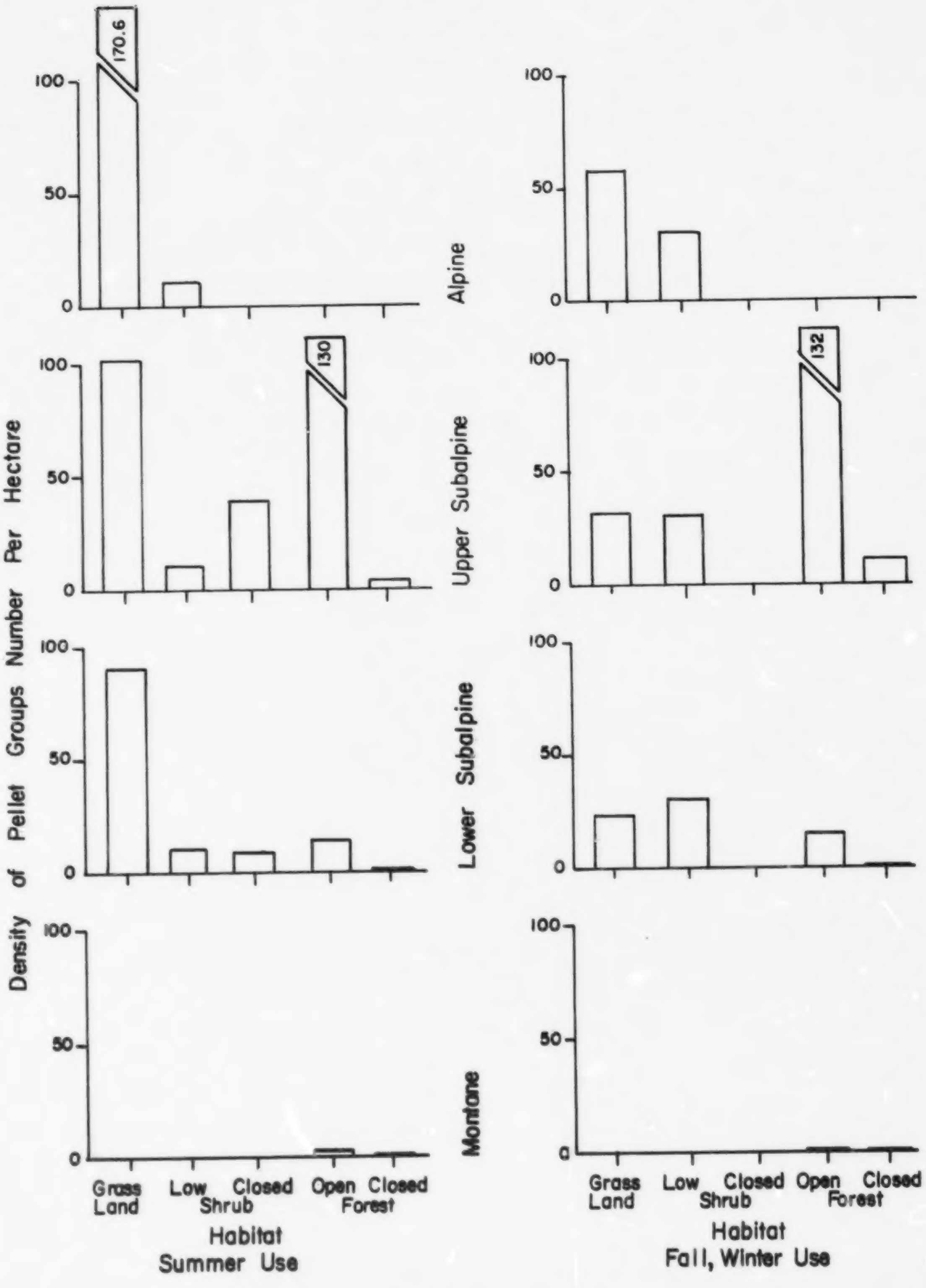
Table 4.23. Highly important Ecosites for mountain goats in KNP based on pellet group counts.

Ecosite	Pellet groups /ha	Ecoregion	Landform	Vegetation
Spring and early summer				
BS1	83.3	Alpine	colluvial	avens tundra
BS2	140.0	Alpine	colluvial	avens tundra, herb tundra
HE2	450.0	Alpine	rock	avens tundra, herb meadow
WF2	125.0	U. Subalpine	colluvial	avalanche>spruce-fir
WF3	131.3	U. Subalpine	coll. & R	open mixed coniferous
WF6	150.0	U. Subalpine	colluvial	avalanche>spruce-fir
WH7	151.2	U. Subalpine	colluvial	moist herb meadow, herb tundra
Late summer, autumn and winter				
HE2	150.0	Alpine	rock	avens tundra, herb meadow
WF2	237.5	U. Subalpine	colluvial	avalanche>spruce-fir
WF3	87.5	U. Subalpine	coll. & R	open mixed coniferous
WF6	70.0	U. Subalpine	colluvial	avalanche>spruce-fir
WH4	66.7	U. Subalpine	coll. & R	open mixed coniferous

Table 4.24. Highly important vegetation types for mountain goats in KNP from pellet group counts.

Vegetation type	Pellet groups /ha	Description
Spring and early summer		
H1	300.0	mountain avens-snow willow-moss campion
H2	450.0	black alpine sedge-everlasting
O4	120.0	Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine
O10	350.0	Engelmann spruce-subalpine fir/heather
O19	300.0	Engelmann spruce-subalpine fir/mountain avens
Late summer, autumn and winter		
C23	26.5	alpine larch-subalpine fir/grouseberry-everlasting
H1	25.0	mountain avens-snow willow-moss campion
H2	50.0	black alpine sedge-everlasting
L7	50.0	arctic willow-cinquefoil
O4	221.4	Engelmann spruce-subalpine fir-whitebark pine-lodgepole pine
O10	350.0	Engelmann spruce-subalpine fir/heather
O14	25.0	Engelmann spruce-subalpine fir/rock willow/bracted lousewort
O19	150.0	Engelmann spruce-subalpine fir/mountain avens

Figure 4.17. Seasonal habitat use by Ecoregion for mountain goats in KNP from pellet group counts.



(WF3) with open coniferous (O4) and subalpine fir krummholz vegetation.

SPECIES ATTRIBUTES

Little is known of the specific food habits of goats in KNP. Holroyd (1967) indicated that winter forage of goats on Mt. Wardle was largely browse including red-osier dogwood, willow, Douglas fir and buffaloberry while in summer forage was mainly grasses and grasslike plants. Saunders (1955) found that the summer diet of goats in Montana was 56% grasses (mainly ***Deschampsia*** spp., ***Festuca*** spp. and ***Poa*** spp.), sedges and rushes, 24% forbs and 16% shrubs (including ***Vaccinium*** spp., ***Salix*** spp. and ***Ribes*** spp.). Shrubs were not eaten in winter, however Douglas fir and subalpine fir comprised 25% of the winter diet.

It appears from the park wildlife cards and the studies by Holroyd (1967) that the most serious mortality factors for goats are natural phenomona such as severe winter weather, avalanches, predation and disease. There are no records of highway mortalities of goats in the park, even though during June and early July goats on Mt. Wardle make almost daily trips to mineral licks adjacent Highway 93 where they are in close proximity to vehicle traffic.

MANAGEMENT CONSIDERATIONS

Although most goat range in KNP is remote and generally isolated from human harassment and development, there are several areas of potential if not real conflict between goat populations and human activities.

The Mt. Wardle area is of special interest because the south facing slopes contain one of the lowest elevation goat winter ranges within the contiguous mountain parks and the licks adjacent the highway bring goats within easy access of tourists during the summer months. Care should be taken to protect these low elevation winter ranges from human disturbance and to minimize the potential for harassment at the roadside licks.

Goats are particularly sensitive to aircraft harassment, especially during the critical late winter and early spring periods. Aerial surveys should be avoided during these periods and other flights should be routed to avoid key goat winter range areas.

Avalanche control activities on the Mt. Whymper and Assiniboine slide paths may affect goats wintering in these areas. The potential for this occurring should be investigated.

BIGHORN SHEEP *Ovis canadensis* SHEE

STATUS AND DISTRIBUTION

In Canada, the range of the Rocky Mountain Bighorn sheep occupies some 35,000 km^2 of the Rocky Mountains mainly east of the Continental Divide between 51 and 55°N (Stelfox 1978). The pervious shale, sandstone and limestone mountains which have developed grassland ranges on the East Slope areas extend across the Rockies onto the West slopes above the Rocky Mountain Trench in the East Kootenay Region of southeastern B.C. where bighorns have traditionally been plentiful. In the East Kootenays bighorns have a patchy distribution along the east side of the Rocky Mountain Trench from near the Canada - U.S. border north to Edgewater (Demarchi 1967). In 1972 a band of 21 bighorns was seen along the Trans Canada Highway east of Golden (Stelfox 1978). Bighorns are also known from the upper Sheep Cr. north of Mount Robson (Cowan and Guiguet 1965).

In KNP, as elsewhere in the Rockies, sheep populations have fluctuated markedly over the last 150 years, largely in response to conditions of overhunting, severe winters, competition from livestock and periodic build-ups of disease and parasites (Stelfox 1978). In his historical account of sheep populations in the Canadian Rockies between 1800 and 1970 Stelfox (1971) indicates that bighorns were abundant in the upper Kootenay and upper Simpson rivers areas in the early 1800's. However, sheep declined dramatically throughout the Rockies during the period 1850 to 1915. In KNP, the Radium band experienced a major die-off about 1922.

Table 4.25. Maximum counts of bighorn sheep from Sinclair and Stoddart Cr. drainages in KNP from October to April, 1980-1983.

Date	Total	M	F	UNK	YOY	YLY	YOY/100F	YLY/100F
April 1980*	81	7	45	2		27		60.0
October 1980	47	11	21		15		71.4	
March 1981**	109							
October 1981	52	10	29		13		44.8	
December 1981	74	19	39		17		43.6	
February 1982**	92	8	15	65		3		20.0
March 1982	54	2	36			16		44.4
April 1981	77	18	43	5		11		25.6
October 1982	62	9	35		18		51.4	
November 1982	54	5	32	2	15		46.8	
April 1983*	108	27	43	24		14		32.6
May 1983**	84	21	36			27		75.0
Mean							51.6	42.9

*park wildlife files
**aerial survey

Table 4.26. Seasonal distribution of bighorn sheep by Ecoregion from pellet group counts.

	Average pellet group /ha		
Ecoregion	Spring to early summer	late summer, autumn and winter	All year
Montane	0.3	77.7	78.0
Lower Subalpine	1.3	0.9	2.2
Upper Subalpine	14.8	6.7	21.5
Alpine	84.2	21.1	105.3

Forest fires during the 1920's improved range conditions and sheep numbers increased through the 1930's and in 1938 there were an estimated 140 sheep in the Radium band (Cowan 1943). A second die-off occurred in the Radium band during the fall and winter of 1941-42 (J. Meredith, park files, Cowan 1943). An estimated 120 (85%) animals perished from a pneumonia-lungworm complex between December 1941 and March 1942. Competition from domestic livestock on the winter range and bad weather were implicated in the die-off. Other populations in the Columbia valley also experienced die-offs while those in the Cross, Mitchell and Simpson River drainages were unaffected.

The Radium band increased to approximately 60 animals by 1946, 80 in 1951 and 175 by 1966 (warden files; Stelfox 1978). During the winter of 1966-67 this band experienced a third die-off in which numbers declined from 175 in 1966 to 40-45 by December 1967. This pneumonia-lungworm related die-off was initiated by deteriorated winter range conditions due to forest encroachment and competition with livestock and deer and inclement weather during the previous winter (Stelfox 1978). Documentation of the 1966-67 die-off and ensuing studies of bighorn sheep populations, distributions, range relationships and disease and parasites in the Canadian national parks are provided by Stelfox (1966, 1971, 1976a, 1976b, 1978).

Productivity in the Radium band returned to normal in 1969 following three years of low productivity during the die-off period. By fall 1970 the park population was estimated at between 80 and 85 animals in the Radium band with an additional 40 animals on the Mitchell Range which wintered in the upper Simpson and Mitchell rivers (Stelfox 1978). The Radium band has increased slowly since 1970, with recent counts (Table 4.25) indicating a present population of between 120 and 130 animals. Stelfox (1978) indicated that during the early 1970's there were an additional 40 bighorns which summered in the Split Peak - Spar Mountain - Mount Wardle areas, wintering outside the park in the upper Simpson and Mitchell drainages. He also reported that 40 bighorns were seen at the south end of the Mitchell Range above the Cross River in the fall of 1963. During the present study, 6 rams were seen on the Mitchell Range south of Pitts Cr. (July 1982), 5 ewes, 2 lambs and 1 ram were seen on Spar Mountain above Lachine Cr. (July 1982) and 2 ewes, 1 yearling, 1 lamb and 2 rams were seen on Mount Wardle (Feb-June 1982). An aerial survey by the Warden Service in October 1983 (Sheehan 1983) found 11 bighorns on the Mitchell Range, 61 on the Brisco Range (Mt. Kindersley) and 18 on the Stanford Range.

Although bighorn numbers have fluctuated markedly in KNP their distribution has remained relatively constant. The current distribution of sheep in the park is very similar to that mapped by Stelfox (1978) (Fig. 4.18). From October to May most sheep in the Radium population range between Sinclair and the Stoddart -Shuswap creeks areas on the west and south facing low elevation (1300-1600 m.) colluvial slopes and glacial terraces above the Columbia River valley. A few range north of Sinclair Cr. as far as Edgewater and Brisco. In 1972 tagged animals from the Radium band were observed as far north as the Kicking Horse River east of Golden (Stelfox 1978). During the present study evidence of wintering sheep was also found on the west facing colluvial slopes at the head of Stoddart Cr. Throughout the winter there is regular movement of sheep between Stoddart and Sinclair creeks and frequent use is made of man made grassland areas and disturbed sites in Sinclair Canyon from the Aquacourt to Radium townsite as well as the Redstreak campground area. Sheep were observed in the area during all months of the winter. During winters of higher snow accumulation sheep make greatest use of the open coniferous slopes and grasslands between Dry Gulch and Shuswap creeks with greatest concentrations occurring on the Stoddart grasslands.

In April and May much of the band moves into Sinclair Canyon to take advantage of early green vegetation on natural and man made grasslands along the south facing slopes of Sinclair Cr. from Radium townsite to John McKay Cr. The few sheep remaining on the Stoddart ranges in May move up Stoddart Cr. to summer in the upper Stoddart, Kimpton and Silt Cr. drainages. By mid-June the Radium band is moving to summer ranges on Mt. Berland and Mt. Kindersley in the upper MacKay, Kindersley, Sinclair and Nixon creeks drainages as well as north along the Brisco Range as far as Luxor Pass. Throughout the summer, groups of sheep (mainly ewes, lambs and yearlings) return to Sinclair Canyon to lick at exposed mineral soil along road cuts and forage on man made grasslands.

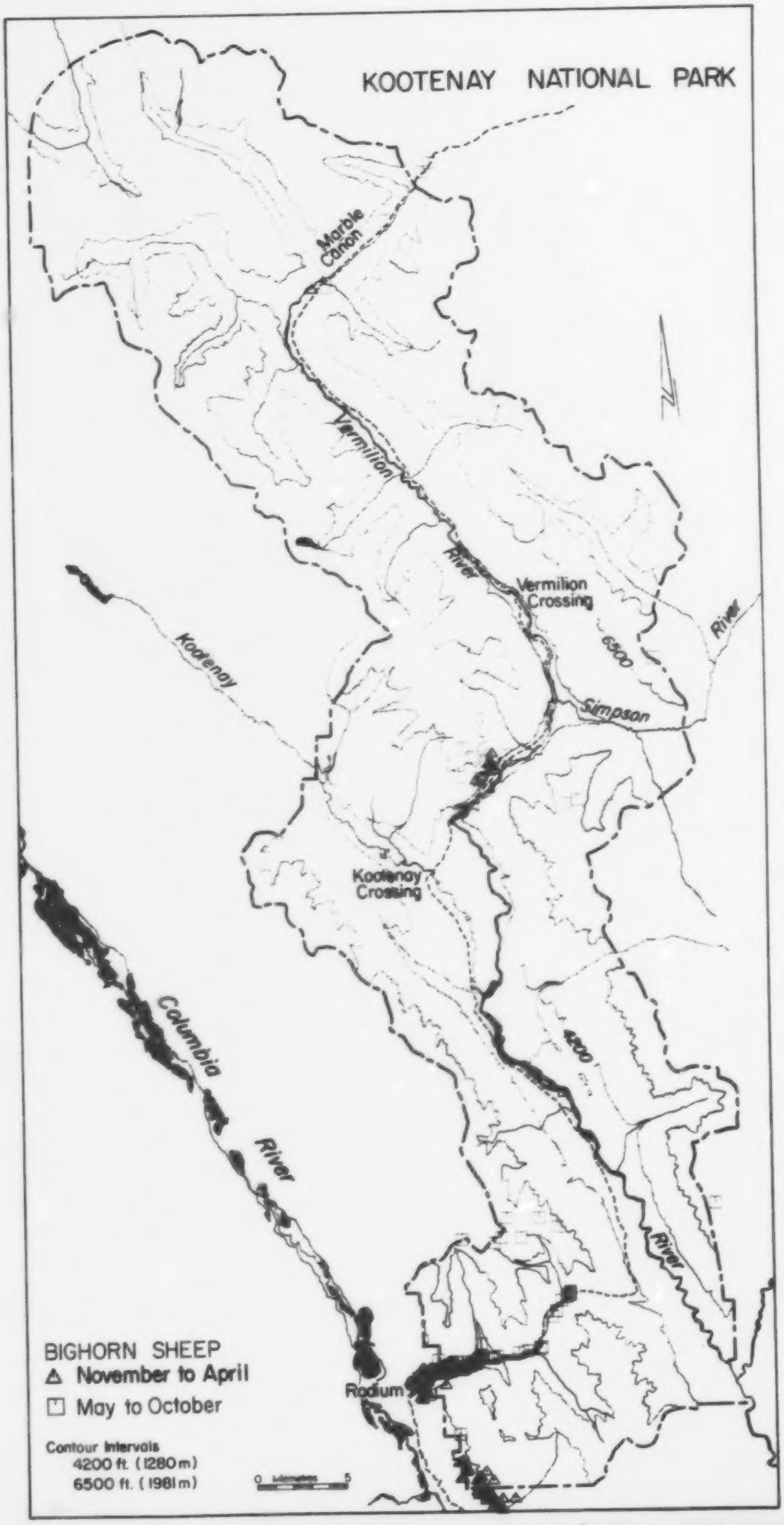
In October and November sheep return from summer ranges to make heavy use of the lower Sinclair Cr. area from John McKay Cr. to Radium townsite before moving southward toward the Stoddart Cr. winter range in early to mid-December. Much of the rut occurs on these areas in and adjacent to Sinclair Canyon, however breeding also occurs on the Stoddart winter range.

Elsewhere in KNP sheep are known to range during summer and early fall along the Mitchell Range from the south park boundary to Split Peak and Spar Mountain including the the upper portions of Pitts, Daer, and Split Peak creeks. Bighorns have also been recorded on southern Hawk Ridge above the Simpson River and from Mt. Wardle. The majority of these animals winter outside the park in the upper Simpson and Mitchell River drainages although recently small numbers of sheep have wintered on the south slopes of Mt. Wardle (1980-81 and 1982-83). In recent years there have also been four observations of bighorns in the upper Vermilion watershed: three from the Vermilion Pass area and one from Marble Canyon. The origins and movements of these sheep are unknown.

HABITAT

In summer, bighorns are found in all Ecoregions, however Upper Subalpine and Alpine Ecosites show the highest use (Table 4.26). On the Mt. Berland-Mt. Kindersley summer ranges, sheep make greatest use of

Figure 4.18. Seasonal distribution of bighorn sheep in KNP from park wildlife cards, 1978-1983.


KOOTENAY NATIONAL PARK
Marble Canon
Vermilion
River
Vermilion Crossing
6500
River
Kootenay
Simpson
Kootenay Crossing
Columbia
River
4200
River
Radium
BIGHORN SHEEP
△ November to April
☐ May to October
Contour Intervals
4200 ft. (1280m)
6500 ft. (1981m)
0 kilometres 5

Alpine and Upper Subalpine colluvial Ecosites (BS2, WF3) with herb meadow (H17), dry tundra (H1) or open mixed coniferous (O4) vegetation. (Tables 4.27, 4.28; Fig. 4.19). Moderate use was recorded on Upper Subalpine colluvial (WF5) and morainal (PL6) Ecosites with a mosaic of spruce-fir forests (C15, C21) and avalanche slopes (S2, S10, L2, H5). On Hawk Ridge sheep summer use was recorded on RD2 with H1 tundra vegetation and on WH6 with spruce-fir forest (C15). On Mt. Wardle bighorns were most frequently seen on the south facing Montane and Lower Subalpine colluvial slopes (DG3, SB4) with open Douglas fir (O5)-avalanche shrub (S6) and open mixed coniferous (O4) vegetation. During the summer months ewe-lamb-yearling groups make frequent trips from the Upper Subalpine and Alpine summer ranges on Mt. Berland - Mt. Kindersley to the Montane colluvial (DG3) and glacial (DR5) Ecosites in Sinclair Canyon where they graze on lawns and seeded roadsides sewn to a variety of grasses (crested wheatgrass, Kentucky bluegrass) and forbs and seek minerals from exposed roadcuts and road surfaces.

In winter sheep are predominantly confined to the Montane Ecoregion (Table 4.26) as snow depths even in the southwest of KNP precludes much winter use of Upper Subalpine and Alpine Ecosites by sheep. Winter use recorded in the Alpine and Upper Subalpine from pellet group counts is mainly from late summer and autumn. Highest winter use occurs on Montane glacial (WY2) and colluvial (DG3) Ecosites with a mosaic of dry Douglas fir open forest (O5) and dry grassland (H19) on west and south facing slopes above the Columbia valley(Tables 4.27, 4.28 and Fig. 4.19). Moderate winter use was recorded in DG1, DR1 and WY1 Ecosites with Douglas fir closed forest (C1). Frequent use is also made of man made grassland and disturbed sites, particularly in spring as these areas in Sinclair Canyon, Radium Hot Springs and Radium Golf Course provide the earliest green vegetation.

SPECIES ATTRIBUTES

Stelfox (1976b) indicated that sheep utilized grasses more than forbs or shrubs during summer on the WLNP, BNP and JNP ranges. Shrub and forb use was greatest on the poorer condition ranges. Grass use was relatively constant throughout the year, but was heaviest during winter, less during spring and autumn and least during summer. During his 1966 investigation of the Stoddart Cr. winter range Stelfox (1966) found sheep made heavy use of preferred shrub species such as saskatoon, mountain maple and chokecherry and moderate to heavy use of less palatable species such as buffaloberry, rabbitbrush, sage, bearberry and snowberry. He found that although wheatgrasses (*Agropyron* spp.) comprised over 75% of the grass cover they were only lightly to moderately used by sheep, the heaviest use being on the less abundant Indian rice grass (*Oryzopsis hymenoides*). June grass (*Koleria cristata*) and bluegrasses (*Poa* spp.) received light to moderate use.

Productivity of sheep varies from year to year in response to weather and range conditions. Since 1980 productivity of the Radium band (autumn ewe/lamb ratio) has averaged 51.6 lambs/100 ewes (Table 4.25). This figure compares closely to that reported by Stelfox (1976b) for BNP bighorns from 1966 to 1971 and is higher than that reported by (Holroyd and Van Tighem 1983) for BNP and JNP in 1978 and 1979.

As discussed earlier sheep populations in the Rocky Mountains of southwestern Alberta and southeastern B.C. are subject to periodic die-offs related to a pneumonia-lungworm disease complex which is aggravated by factors of over-crowding, deteriorated winter range conditions, severe weather, competition from livestock or other ungulate populations and human disturbance.

The most consistantly reported source of sheep mortality in park wildlife cards is collisions with motor vehicles. Of 46 mortalities recorded since 1951, 21 (45%) were highway mortalities, 11 (24%) were disease related and the remaining 14 were from unknown causes (6), poaching (5) and predation (3).

MANAGEMENT CONSIDERATIONS

The Radium bighorn sheep population is of particular management concern for a number of reasons. The traditional winter, spring and autumn ranges are located in the area of KNP and adjacent provincial lands which contain a high concentration of human development. Probably no other ungulate in the park is subjected to as high a degree of human contact as are these sheep. The extent to which this disturbance affects the sheep is unknown, however certainly all the highway mortality of sheep is directly related to the development along the lower Sinclair Cr..

The fact that the major winter range of the Radium band at Stoddart Cr. lies outside the park boundary is also of concern. More effective management of this range and the sheep population would be

Figure 4.19. Seasonal habitat use by Ecoregion for bighorn sheep in KNP from pellet group counts.

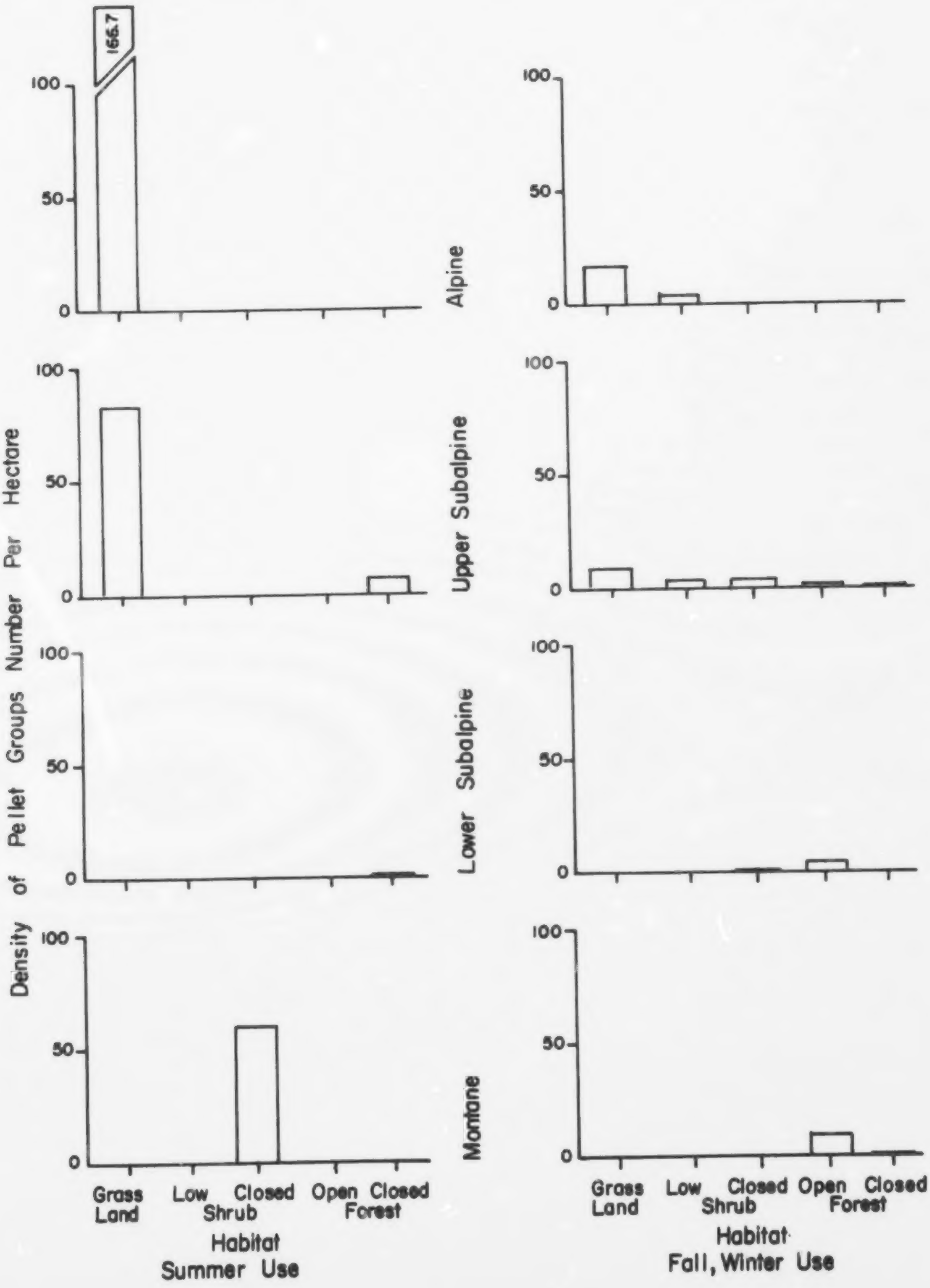


Table 4.27. Highly important Ecosites for bighorn sheep in KNP based on pellet group counts.

Ecosite	Pellet groups /ha	Ecoregion	Landform	Vegetation
Spring and early summer				
BS2	320.0	Alpine	colluvial	avens tundra, herb tundra
WF3	137.5	U. Subalpine	coll. & R	open mixed coniferous
Late summer, autumn and winter				
DG3	1535.3	Montane	colluvial	open Douglas fir, grassland
RD2	100.0	Alpine	colluvial	avens tundra, herb tundra
SB4	33.3	L. Subalpine	coll. & R	open mixed coniferous
WF3	62.5	U. Subalpine	coll. & R	open mixed coniferous
WY2	85.7	Montane	glacial	open Douglas fir, grassland

Table 4.28. Highly important vegetation types for bighorn sheep in KNP from pellet group counts.

Vegetation type	Pellet groups /ha	Description
Spring and early summer		
H1	75.0	mountain avens-snow willow-moss campion
H17	500.0	everlasting-grouseberry
O4	150.0	Engelmann spruce-subalpine fir-whitebark pine
Late summer, autumn and winter		
H1	50.0	mountain avens-snow willow-moss campion
H19	3325.0	bluebunch wheatgrass-hairy wild rye-showy aster
O5	25.0	Douglas fir/juniper/bearberry
O19	200.0	Engelmann spruce-subalpine fir/mountain avens

facilitated by incorporation of this range into the park.

5. MANAGEMENT CONSIDERATIONS

During the wildlife inventory some issues or potential issues related to species and habitat management in KNP came into focus. Where these affect individual species they are discussed in the species accounts (section 4.); major points are summarized here. In addition, we outline the more important wildlife habitats in KNP and some of the potential issues in habitat management that may affect species management.

It is anticipated that this report and Volume I (Achuff *et al.* 1984) will be major tools for the preparation of wildlife management plans. Because of the predictive capability of the map and wildlife legend, the user can develop maps and concepts that are beyond what are presented in this report. Such interpretations can provide new insights into land use planning and wildlife management. The inventory has an important role to play in future wildlife habitat management in KNP.

CRITICAL WILDLIFE AREAS

We recommend that management strategies be devised for protecting critical wildlife areas. Critical wildlife areas include specific geographical areas or locations, such as the Stoddart Creek bighorn winter range, or habitats of high importance to wildlife, defined on the basis of Ecosites. Highly important Ecosites are identified in the Ecosite accounts in Volume I (Walker *et al.* 1984); their distribution can be determined from the Map Supplement. Protection of wildlife values in such areas need not necessarily exclude use or development. Depending on the species for which the area is critical, there will be periods of time when the area can be used without harming wildlife, and there will be types of activities that will not disturb the area. Wildlife constraints can be assessed by reviewing the appropriate species accounts, above.

A preliminary list of critical wildlife areas follows:

- Kootenay River valley: contains critical winter range for elk and moose and summer range for white-tailed deer. Particularly important are fluvial landforms of the FR, HD, and AT Ecosections and morainal landforms of the DR Ecosection.
- Dolly Varden Creek and local wetlands in the Kootenay valley: these areas support wetland communities of birds, amphibians and mammals, associated with the VL and DR Ecosections, that are unique in the park. Many of these wetlands are maintained in their productive state by beaver and contain the most species and highest densities of wildlife of any areas in KNP; consequently they are highly sensitive to disturbance.
- South face of Mt. Wardle: contains the largest mountain goat population in KNP. This population is subject to harassment and mortality at semi-natural licks along the Banff-Windermere Highway.
- Lower Sinclair Creek and the lower slopes (DG) and terraces (WY) above the Columbia valley from Sinclair Creek to Stoddart Creek: contains critical autumn, winter and spring range for the largest population of bighorn sheep in the park as well as mule and white-tailed deer. These populations are subject to harassment and mortality in the Sinclair Canyon area and on provincial lands adjacent the southwest boundary at Stoddart Creek. Habitat loss through development, agriculture and forest succession is of concern, particularly on provincial lands.
- Stoddart Creek: the Douglas fir-ponderosa pine/wheatgrass (O24) and bluebunch wheatgrass-hairy wild rye-showy aster (H19) vegetation types are unique to KNP and to the Mountain National Parks

(Achuff and Dudynsky 1984). The Douglas fir-ponderosa pine open forest and grassland is not only critical winter range for bighorn sheep, but the area supports a high diversity of wildlife and serveral bird species occur nowhere else in KNP. Much of this area is currently outside the park boundary and steps should be taken to hasten its incorporation into the park.

TRANSPORTATION CORRIDOR

Increasing traffic volume along the Highway 93 in KNP has resulted in a dramatic increase in wildlife mortality through vehicle-wildlife collisions, in recent years. Although many wildlife species are affected, some 80% of the kill is sustained by three species: elk, white-tailed deer and mule deer. From 1980 to 1983 an average of 26 elk, 10 white-tailed deer and 6 mule deer have been killed by vehicles. Most of the mortality occurs during the summer and autumn when traffic volumes are highest and when these species make greatest use of the valley bottom habitats through which the highway passes.

Ungulates are attracted to the highway corridor, primarily because of the availability of forage and edge habitats and secondarily by the availability of minerals both from several roadside licks and from salt applied to the road surface. Forest succession in the absence of fire has gradually reduced available open forest and meadow habitats elsewhere in the Montane, hence the highway corridor has become an important source of forage, especially for elk, during the spring, autumn and early winter.

Large carnivores, mainly coyotes and lynx, are attracted to the valley bottoms because of the high prey densities. However, they are also attracted to the roadsides by the availability of carrion in the form of road-killed ungulates which often places them in conflict with vehicles. The removal of road-kills far away from the highway corridor would reduce the potential hazard for carnivores.

Continued increases in highway mortality in KNP will be to the detriment of these species. However, measures to discourage the use of roadsides by ungulates such as fencing, seeding of unpalatable plant species or use of deterants may, in themselves be detrimental as elk, in particular, have become increasingly dependant on roadside vegetation for forage. Therefore, if measures to reduce ungulate highway mortality through discouraging use of the right-of-way are to be successful consideration must be given to enhancing existing ranges or creating new ranges away from the highway corridor as an alternative and replacement for the roadside areas.

Other measures to reduce highway mortalities include finding effective alternatives to road salt to reduce the attractiveness of roads and rescheduling commercial vehicle traffic to avoid the early morning and evening periods which are peak hours of ungulate use of roadsides.

WILDLIFE MONITORING

Periodic monitoring of wildlife populations in national parks is essential to ensure that unnatural changes and population declines are recognized promptly. Monitoring is particularly important for species or populations that do not remain in the park all year long (eg. elk, mule deer, white-tailed deer, bighorn sheep that winter outside the park, animals that range outside the park during hunting seasons), populations that are rare or endangered outside the park, or populations that come into contact with transportation corridors or facilities within the park.

Population monitoring has several benefits:

•Population declines or changes in productivity can be detected early and the stresses causing them can be identified and, if necessary, dealt with in a timely manner.
•Accurate assessments of population size and structure will allow resource managers to model the impacts of proposed developments and greatly improve the effectiveness of EARP.
•Post-development wildlife monitoring will show if predicted impacts do occur and will reveal the magnitude of the impacts. The results should be more accurate information and better environmental impact assessments.
•Assessment of population changes over periods of several years will allow correlation of these changes to changes in weather, predators, food supply, and land use. This will ultimately add to our overall understanding of wildlife ecology in the park and allow more informed wildlife management in relation to human activities.

Aerial ungulate surveys are currently flown each year and should be continued, but these surveys should be standardized in terms of route, flight speed, elevation, and observers. In addition, intensive ground searches of selected areas are superior to single aerial surveys for monitoring most ungulate populations and should be continued to supplement aerial surveys.

Other monitoring techniques should be derived from techniques used during this project, where appropriate, to yield results which can be related to the baseline data presented here. The following specific methods are recommended:

Permanent winter track count transects could be used to monitor ungulate, carnivore, snowshoe hare and red squirrel population trends. Track count transects should be conducted at about the same time of the winter so as to reduce any variability caused by behavioural changes between early and late winter.

Breeding bird survey routes monitor song birds. One route has been established in the park as part of the CWS-US Fish and Wildlife Service program. This route should continue to be monitored once per summer. Breeding bird census plots were established at Stoddart Cr. and Dolly Varden Cr. as part of this inventory. The plots were sampled to estimate the actual density of breeding birds using the spot-mapping method. To monitor long term changes in breeding bird populations we recommend that these plots be censused every 5 to 10 years.

Ungulate survey routes are described in this report. They are road-based and should be surveyed annually when ungulate populations are concentrated in sight of the roads. These surveys would provide valuable data on large mammal productivity, survival and distribution.

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APPENDIX A. CHECKLIST OF THE BIRDS OF KOOTENAY NATIONAL PARK.

prepared by Ray M. Wershler

This 1984 update takes into account all park records up to and including the autumn of 1983. A total of 182 bird species has been recorded in the park and another nine species are listed as hypothetical. About 120 species are believed to breed or have bred within the park boundaries. The names and sequence of birds follows the American Ornithologists' Union (A.O.U.) 1982 checklist.

Information for this checklist was provided by the Canadian Wildlife Service wildlife inventory, park wildlife observation cards, and files maintained by Park Wardens and Naturalists. Especially helpful was ***The Avifauna of Kootenay National Park*** by Kevin Van Tighem (1977).

LEGEND

Abundance	- abundance of the species in preferred habitat in the appropriate season.
c - common	- seen on almost any field trip.
u - uncommon	- often seen, but in low numbers and not on every occasion.
r - rare	- seen only on a few occasions each year and not necessarily every year.
Status	- principal time of occurrence in the park.
P - Permanent	- year-round resident which breeds or is suspected to breed.
M - Migrant	- regular transient during spring, autumn or both.
SV - Summer Visitor	- non- or post-breeding wanderer, sporadic occurrence.
WV - Winter Visitor	- sporadic visitor during the non-breeding season.
S - Summer	- summer resident which breeds or is suspected to breed.
W - Winter	- winter resident.
H - Hypothetical	- unverified record.
A - Accidental	- verified record, usually only one, unlikely to occur again
*	- species known to or believed to breed in the park.

Species	Status	Species	Status
Common Loon	uM, uSV	Osprey	rM, rSV
Pied-billed Grebe*	rS	Bald Eagle	uM, rSV
Horned Grebe*	rM, rS	Northern Harrier	rM
Red-necked Grebe	rM	Sharp-shinned Hawk*	uS
Eared Grebe	rM	Cooper's Hawk*	uS
Western Grebe	rM	Northern Goshawk*	uP
Great Blue Heron	uM, uSV	Swainson's Hawk	rM
Tundra Swan	rM	Red-tailed Hawk*	cS
Trumpeter Swan	H	Rough-legged Hawk	rM
Snow Goose	rM	Golden Eagle*	uS, rW
Canada Goose*	cM, rS	American Kestrel*	uS
Green-winged Teal*	uM, rS	Merlin	rM
Mallard*	cS	Prairie Falcon	H
Northern Pintail	rM, rSV	Spruce Grouse*	cP
Blue-winged Teal*	uM, rS	Blue Grouse*	uP
Cinnamon Teal	rM	White-tailed Ptarmigan*	uP
Northern Shoveler	rM, rSV	Ruffed Grouse*	cP
American Wigeon*	uM, rS	Sora*	uS
Redhead	rM	American Coot*	cS
Ring-necked Duck*	uS	Sandhill Crane	H
Lesser Scaup	rM, rSV	Killdeer*	cS
Harlequin Duck*	uS	Greater Yellowlegs	H
Surf Scoter	rM	Lesser Yellowlegs	uM
White-winged Scoter	rM, rSV	Solitary Sandpiper*	uS
Common Goldeneye	rM	Spotted Sandpiper*	cS
Barrow's Goldeneye*	uM, rS	Western Sandpiper	H
Bufflehead*	cS	Least Sandpiper	rM
Hooded Merganser	rM	Baird's Sandpiper	rM
Common Merganser*	rS	Short-billed Dowitcher	H
Red-breasted Merganser	rM	Common Snipe*	uS
Ruddy Duck	rM	Wilson's Phalarope	rM

Red-necked Phalarope	rM
Long-tailed Jaeger	A
Bonaparte's Gull	rM
Sabine's Gull	A
Ring-billed Gull	rM, rSV
California Gull	rM, rSV
Rock Dove	rSV
Mourning Dove	uM
Flammulated Owl	H
Western Screech-Owl	A
Great Horned Owl*	uP
Northern Hawk-Owl*	rP
Northern Pygmy-Owl*	uP
Barred Owl*	rP
Great Gray Owl*	rP
Short-eared Owl	rM
Boreal Owl*	uP
Northern Saw-whet Owl*	rP
Common Nighthawk*	uS
Black Swift*	uS
Vaux's Swift	rSV
Black-chinned Hummingbird	H
Calliope Hummingbird*	rS
Rufous Hummingbird*	cS
Belted Kingfisher*	uS
Yellow-bellied Sapsucker*	cS
Downy Woodpecker*	rP
Hairy Woodpecker*	uP
Three-toed Woodpecker*	cP
Black-backed Woodpecker*	rP
Northern Flicker*	cS
Pileated Woodpecker*	uP
Olive-sided Flycatcher*	cS
Western Wood-Pewee*	cS
Alder Flycatcher*	rS
Willow Flycatcher*	uS
Least Flycatcher*	rS
Hammond's Flycatcher*	cS
Dusky Flycatcher*	uS
Western Flycatcher*	rS
Western Kingbird	rSV
Eastern Kingbird*	uS
Horned Lark*	rM
Tree Swallow*	uS
Violet-green Swallow*	cS
Northern Rough-winged Swallow*	cS
Bank Swallow*	uS
Cliff Swallow*	cS
Barn Swallow*	cS
Gray Jay*	cP
Steller's Jay*	uP
Clark's Nutcracker*	cP
Black-billed Magpie	rWV
American Crow	rSV, rWV
Common Raven*	cP
Black-capped Chickadee*	cP
Mountain Chickadee*	cP
Boreal Chickadee*	cP
Red-breasted Nuthatch*	cP
White-breasted Nuthatch	rWV, rSV
Brown Creeper*	uP
Rock Wren*	rS

Winter Wren*	cS
American Dipper*	cP
Golden-crowned Kinglet*	cP
Ruby-crowned Kinglet*	cS
Mountain Bluebird*	uS
Townsend's Solitaire*	uP
Veery	H
Swainson's Thrush*	cS
Hermit Thrush*	cS
American Robin*	cS
Varied Thrush*	cS
Water Pipit*	cS
Bohemian Waxwing*	uP
Cedar Waxwing*	uS
Northern Shrike	rM
Loggerhead Shrike	H
European Starling*	uS
Solitary Vireo*	cS
Warbling Vireo*	cS
Red-eyed Vireo*	rS
Tennessee Warbler*	uS
Orange-crowned Warbler*	cS
Yellow Warbler*	uS
Magnolia Warbler	rS
Cape May Warbler	A
Yellow-rumped Warbler*	cS
Townsend's Warbler*	cS
Blackpoll Warbler*	rS
American Redstart*	uS
Northern Waterthrush*	uS
MacGillivray's Warbler*	cS
Common Yellowthroat*	cS
Wilson's Warbler*	cS
Western Tanager*	cS
Black-headed Grosbeak	rSV
Lazuli Bunting	rS
Chipping Sparrow*	cS
Clay-coloured Sparrow	rM
Brewer's Sparrow*	rS
Vesper Sparrow*	uS
Lark Bunting	A
Savannah Sparrow*	uS
Le Conte's Sparrow	A
Fox Sparrow*	cS
Song Sparrow*	uM, rS
Lincoln's Sparrow*	cS
Golden-crowned Sparrow	A
White-crowned Sparrow*	uS
Dark-eyed Junco*	cS, rWV
Snow Bunting	uM
Red-winged Blackbird*	cS
Western Meadowlark	uM, rSV
Yellow-headed Blackbird	rSV
Rusty Blackbird	rM
Brewer's Blackbird	rM
Brown-headed Cowbird*	uS
Rosy Finch*	cS
Pine Grosbeak*	cP
Purple Finch*	uS
Cassin's Finch*	rS
Red Crossbill*	uP
White-winged Crossbill*	uP

Common Redpoll	uW
Pine Siskin*	cS
American Goldfinch	rM
Evening Grosbeak*	cS
House Sparrow	rSV

MAPS NOT

FILMED

CARTES

OMISES